Materials Engineering in Product Design & Manufacture

Materials & Methods

May 1955

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Improving Product Quality Through Better Materials—A Special Report page **119**

Engineering Materials in Nuclear Power Plants page 98

New High Strength Nylon page 108

Magnesium-Ferrous Castings page 114

Polysulfide Liquid Polymers page 110

Modified 18:8 Stainless for Higher Temperatures page 117

Latest on Electroless Nickel Plating page 104

Complete Contents page 1

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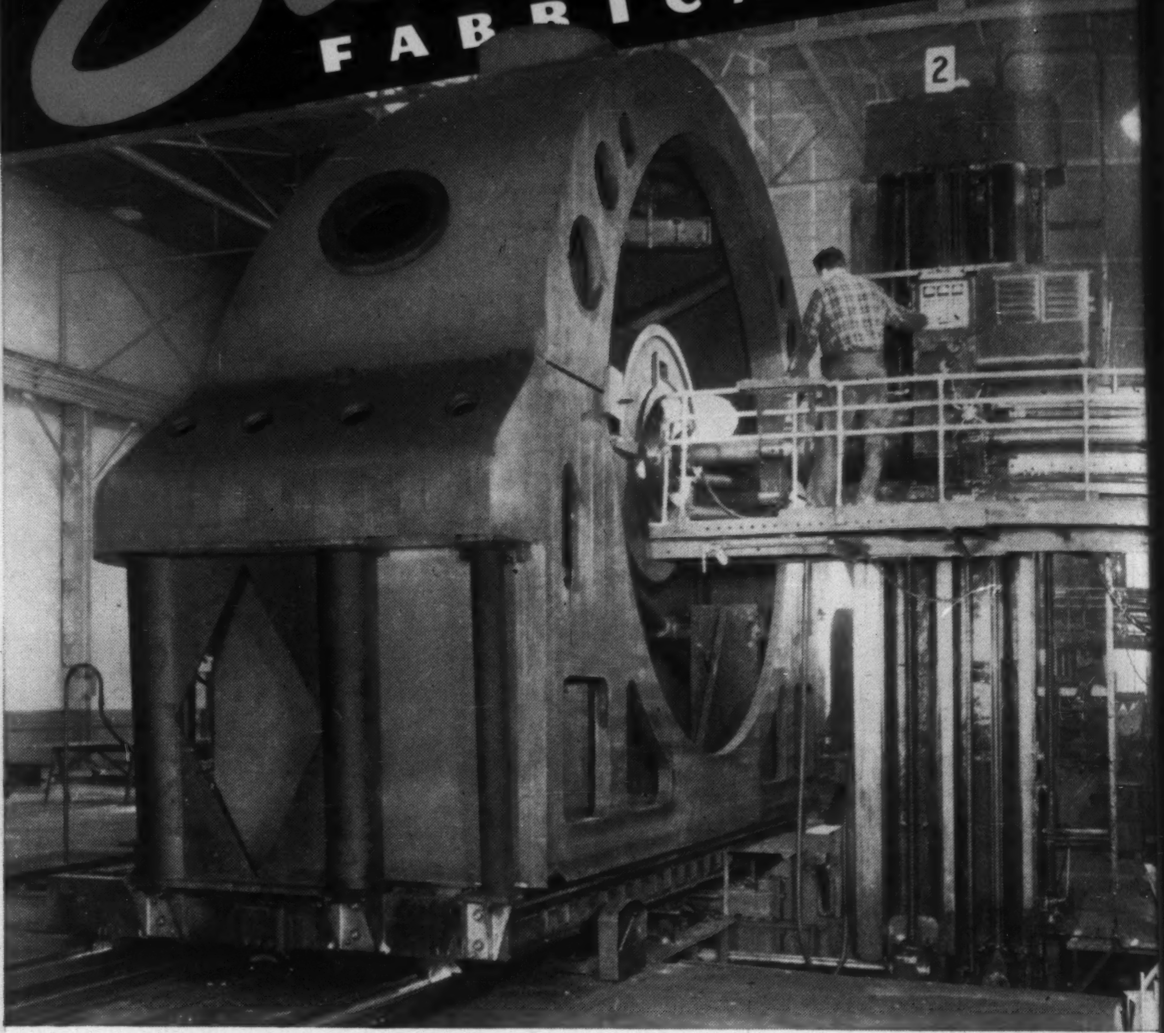

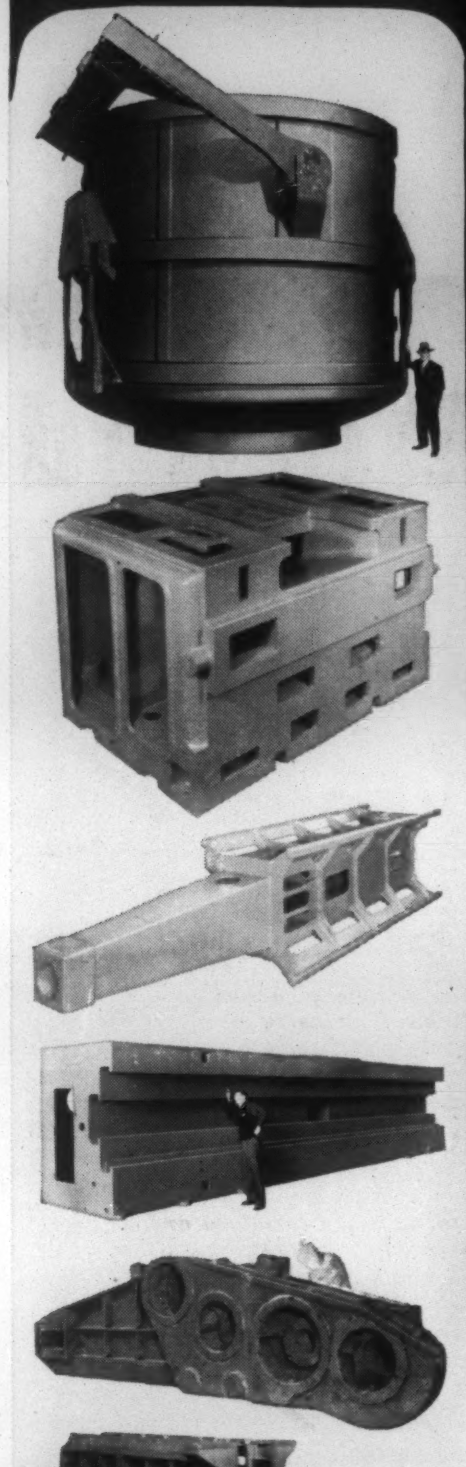

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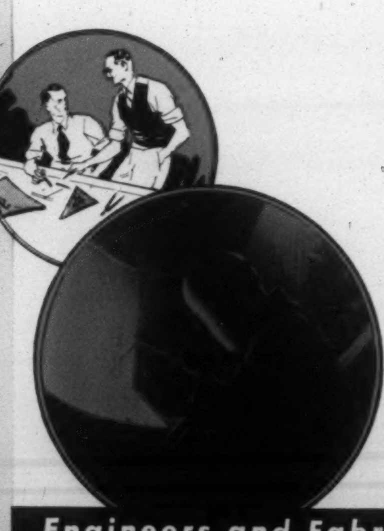

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FEATURE ARTICLES

Engineering Materials in Nuclear Power Plants .... *D. O. Leeser* **98**
An up-to-date account on what properties are required and which materials look most promising for nuclear power equipment

Electroless Nickel Plating .... *J. L. Chinn* **104**
Developed about two years ago, the process has now been widely adopted and has resulted in many cost savings

New High Strength Nylon .... *Malcolm W. Riley* **108**
Extruded film and large molded parts are easily formed. Potential applications are in most fields of industry

Polysulfide Liquid Polymers .... *J. S. Jorczak, D. Dworkin* **110**
The five grades available are used for sealants, flexible molds, modifying epoxies and leather impregnants

Magnesium-Ferrous Castings .... *H. W. Crusey* **114**
Magnesium's lightness and steel's strength are combined and used to advantage for aircraft and electronic components

Modified 18:8 Stainless for Higher Temperatures **117**
One step in the direction of conserving strategic metals by adapting leaner alloys to more severe service

New Low-Cost Plastics Sandwich Panels **150**
More economical light-weight foam construction extends use of sandwich materials

Materials at Work **107, 116**
Forged Steel Cones. Precision Brazing. Foamed Plastics

SPECIAL REPORT

Improving Product Quality Through Better Materials **119**

ENGINEERING FILE FACTS

Wrought Aluminum in Order of Increasing Hardness **145**

Wrought Aluminum in Order of Increasing Strength **147**

DEPARTMENTS

The Materials Outlook **3**
Materials Briefs **7**
Men of Materials **9**
Materials Engineering News **11**
Reader Service **67**
Manufacturers' Literature **68**
One Point of View **97**
New Materials, Parts, Finishes **153**
Contents Noted **181**
News of Engineers, Companies, Societies **218**
Meetings & Expositions **240**
Advertisers and Their Agencies **284**
Last Word **286**

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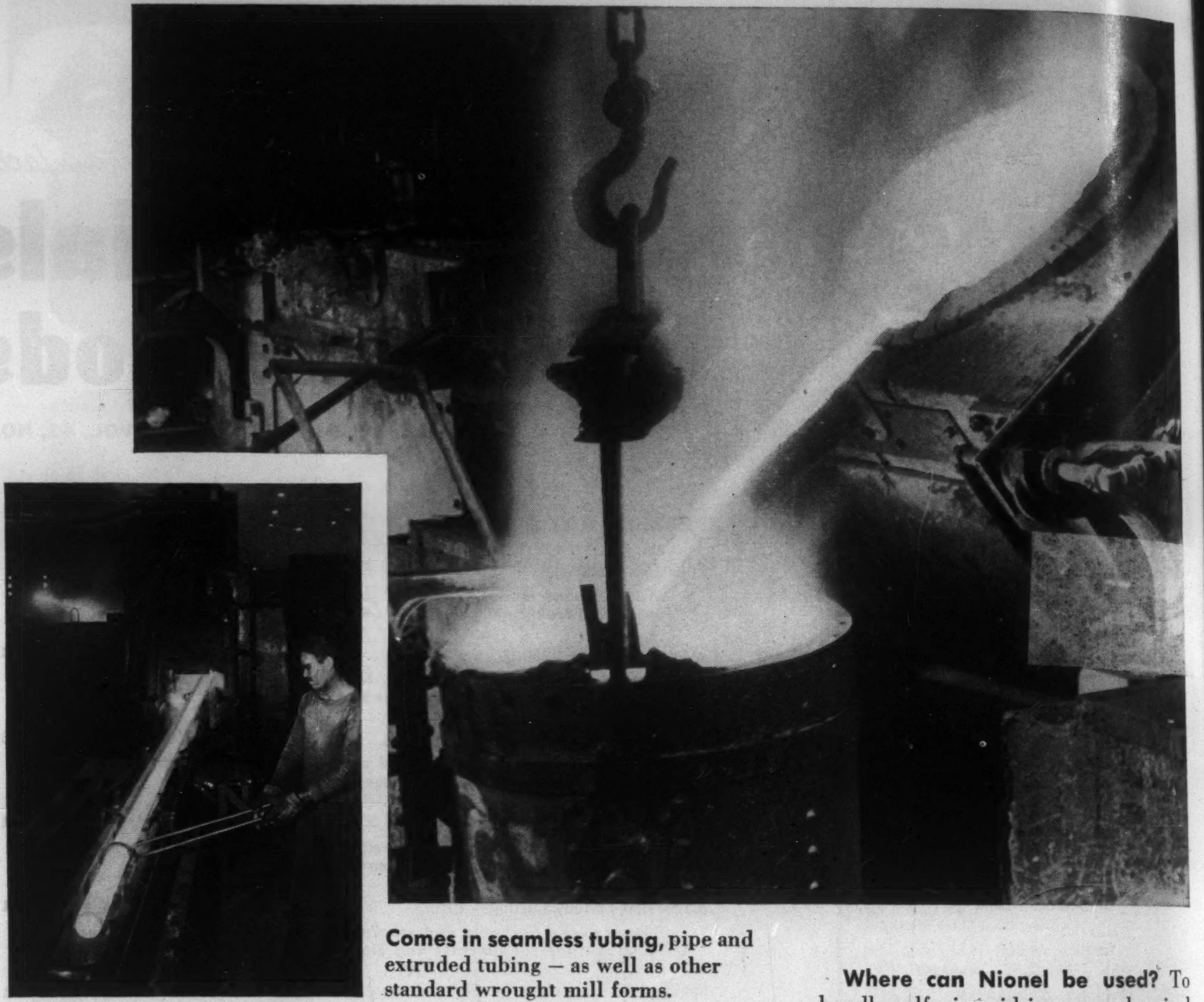

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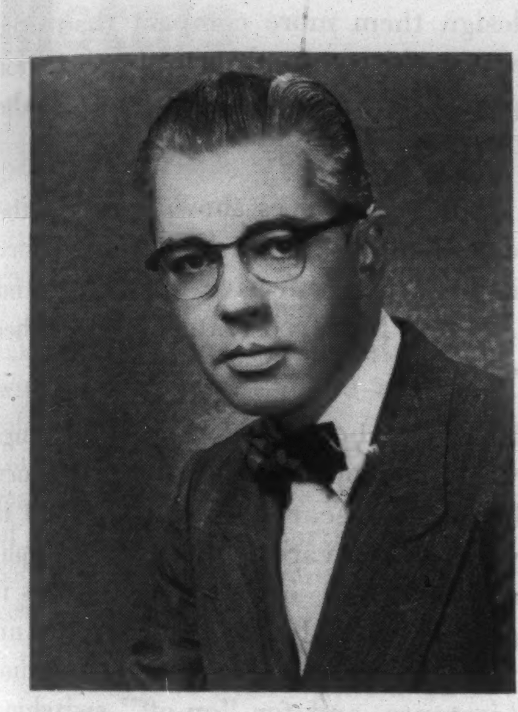
Men of Materials...

Finlay says . . .

"Production use will solve titanium's troubles"



Dr. Walter L. Finlay was appointed research manager of Rem-Cru Titanium Inc. in 1951, when the corporation was formed. In 1954 he was appointed vice president. Dr. Finlay has been active in chemical and metallurgical research for Remington Arms Co. since 1936. He has been in close touch with the economic and technological developments associated with titanium since the metal has been used in structural applications.

"Industry is wondering about the wonder metal titanium. The new metal stands alone among structural materials in its combination of properties: it is light, strong, corrosion-resistant and ductile. But, as has been said with varying degrees of heat, the shop man wonders when breakage rates will drop; the purchasing agent wonders when finished price will be halved; the designer wonders when he will get the super wonderful properties he hears about, rather than only slightly wonderful ones now available; the inspector wonders when sheets will have flawless, flatter surfaces; and the government wonders what it is getting for its money and who is going to use all the raw titanium sponge it has contracted to buy.

"Titanium does face roadblocks. There is not enough primary titanium capacity to supply a really large production application. Technical difficulties with present grades exist. There is need for still better design properties to justify the use of a new, more costly material. And the cost of titanium is still very high.

"However, an examination of the steps that have been taken during the last year to break down these road-blocks leads us to a conclusion we are sure is realistic. Because it is new and flexible, the titanium industry has treated its problems as opportunities to make drastic revisions in equipment and processes. The last twelve months have witnessed dramatic improvement in titanium sponge quality, titanium mill product quality, and the quality of aircraft part fabrication and assembly. This means that right now the titanium industry offers metal with properties which warrant the use of all the 7200 tons produced. Some improvements in the immediate future, notably in heat treatment and development of alloys, which will follow later this year and in 1956, are making possible significant extensions of the design limits of the metal. Importantly, the advances of the last year and the additional quality improvements constantly appearing, justify a firm tonnage position for titanium in the aircraft field. And with volume production, as with any other material or product, the halving or more than halving of mill product prices will follow firm application commitments for an annual volume in the range of 10,000 to 20,000 tons."

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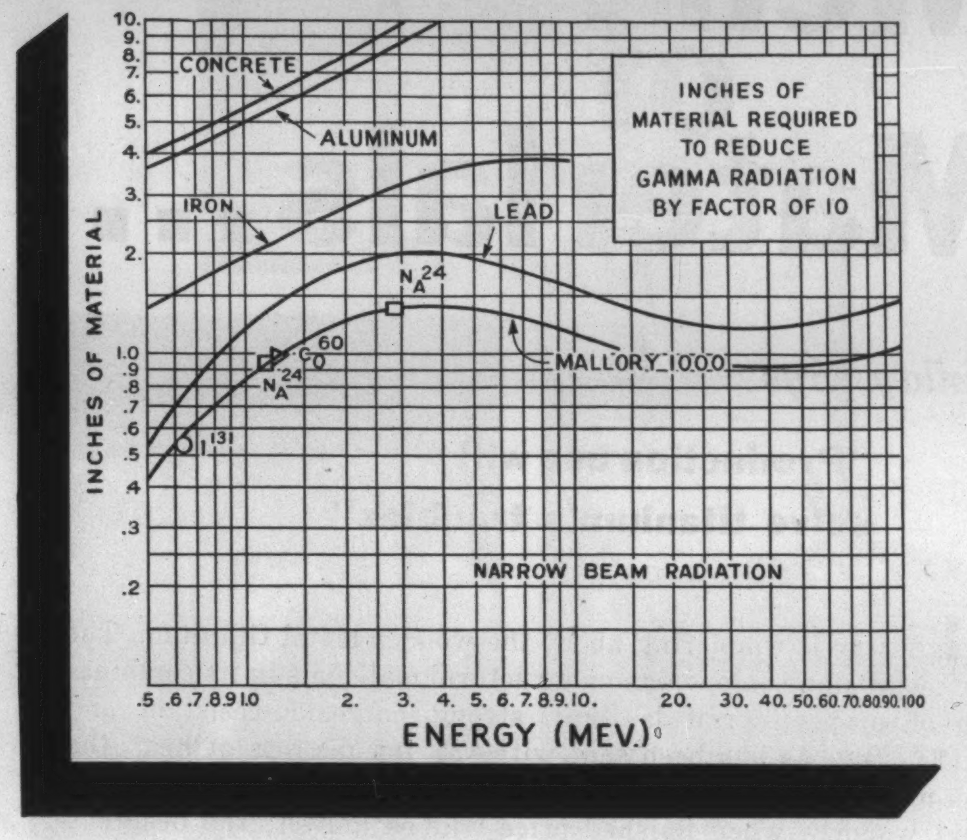

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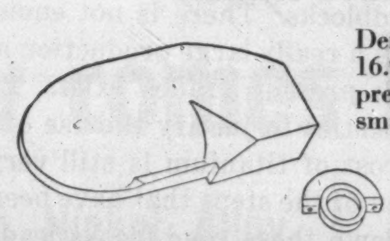

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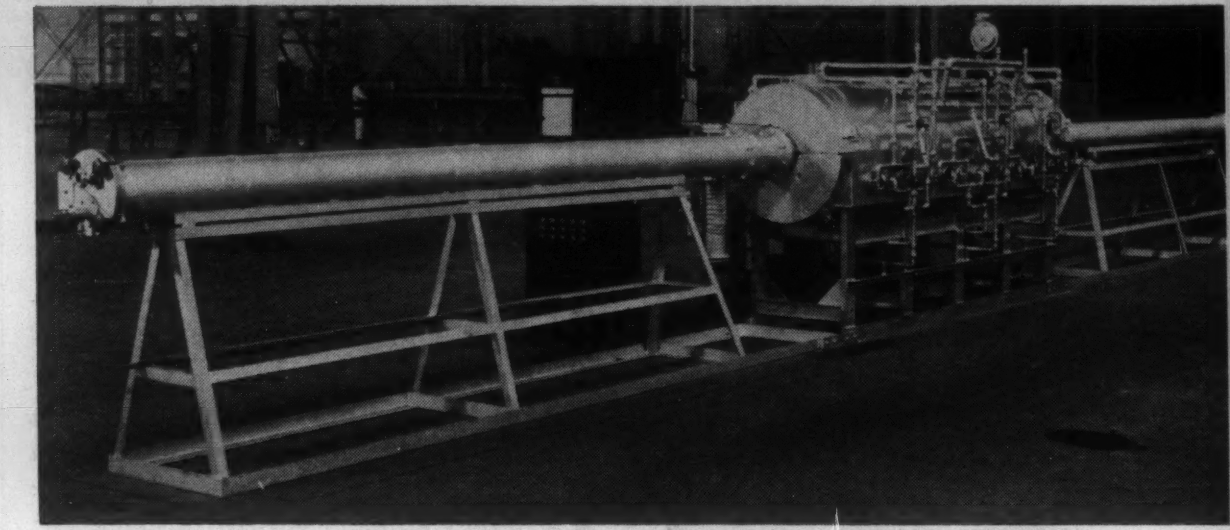
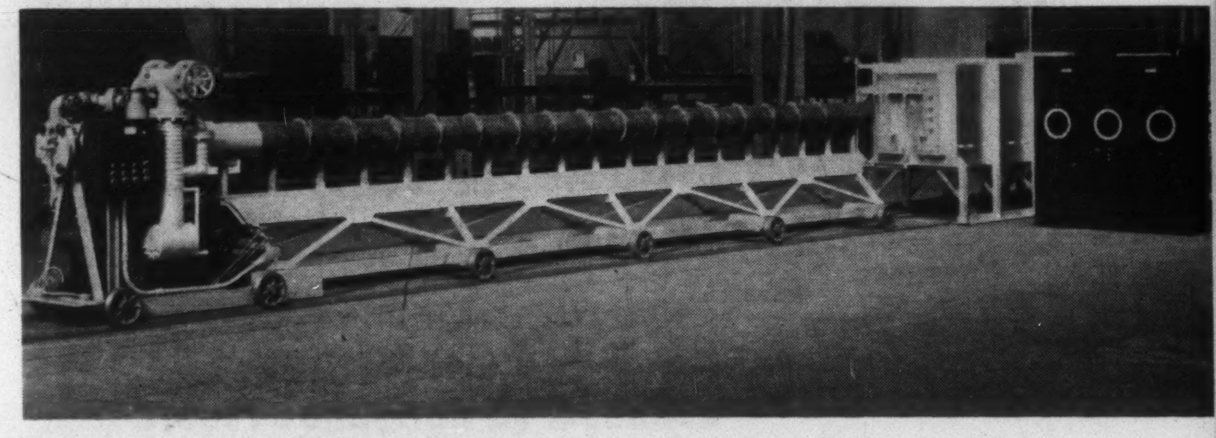
MATERIALS ENGINEERING News Digest

Vacuum Annealing Upgrades Metals



A 3-stage vacuum annealing furnace *recently installed by High Vacuum Engineering Corp. has a 3-stage, semi-continuous vacuum system. Metal is inserted in first chamber, evacuated, heated under vacuum in center chamber, and allowed to cool in far chamber.*



Retort of vacuum annealing furnace *at Superior Tube Co. has a 24-ft hot chamber.*

Take a brittle, rejected titanium forging with a tensile strength as low as 60,000 psi, cook it at 1200 F in a vacuum of 1 micron or less. After 36 hr, take out an annealed, bright part with higher ductility and a tensile strength as high as 160,000 psi. Expensive? Certainly, but it may mean the recovery of a stack of turbine disks worth nearly $50,000. Vacuum annealing doesn't cost that much.

Several titanium fabricators are trying out high vacuum annealing to improve the strength and quality of parts, and to eliminate the biggest bugaboo in titanium fabrication—hydrogen embrittlement. Three or four companies have bought high vacuum annealing equipment for production use.

One sparkplug behind vacuum annealing — or degassing — is a small company called High Vacuum Equipment Corp., headquartered in Hingham, Mass. Kinetics Corp., a subsidiary of High Vacuum, has been formed as a service organization to vacuum-anneal titanium and other metals on a production basis for fabricators who do not want to buy vacuum equipment, or who want to test the method on their own products. Kinetic's high vacuum equipment can handle any parts that will fit in a hot zone 26½ in. i.d. and 27 in. long. Turbine disks up to 1½ in. thick and 2 ft in diameter have been annealed in the equipment, as well as strips, wire, formed parts, castings, and billets. Parts annealed, or degassed, under high vacuum have shown remarkable increases in ductility, fatigue strength and tensile strength.

Time at temperature is a function of the thickness of the part for degassing titanium. Kinetics has found that a 2-in. thick plate of titanium should be cooked for 36 hr at less than 1 micron pressure to ensure highest tensile strength.

At present, most titanium vacuum annealing is experimental, though Superior Tube Co. is using its 24-ft capacity furnace for production of annealed welded tubing. Other furnaces of a semi-continuous three stage type have been delivered to Westinghouse, Metals and Controls, and other companies. High Vacuum Equipment has plans to build larger capacity furnaces. On the fire is a king-sized, semi-continuous type that will vacuum degas and anneal 2 tons of titanium at a throw. The retort of the unit will hold sheets up to 12 by 4 ft.

Vacuum annealing not only removes hydrogen, but many other impurities as well. No scale forms, and on emergence from the annealing furnaces, sheet and parts have a bright clean appearance. No pickling is necessary, which is an important consideration, since a pickling bath is a notorious source of hydrogen embrittlement.

Heat treatment in the one-micron-and-less range is not restricted to titanium. Used with other metals and alloys, it gives properties approaching those attained with vacuum melting.

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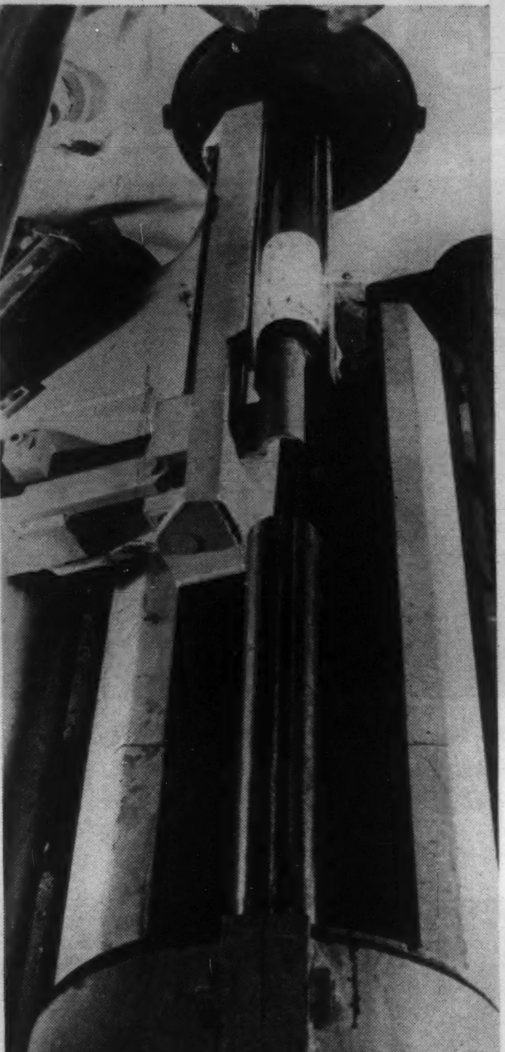
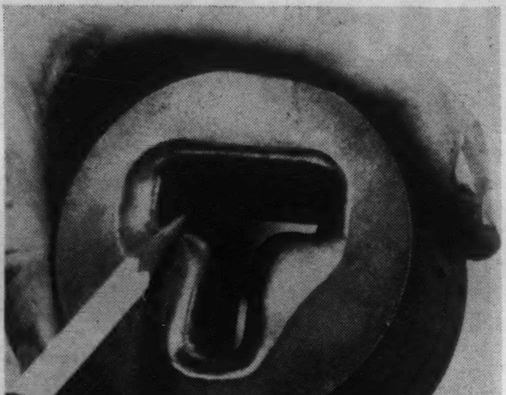




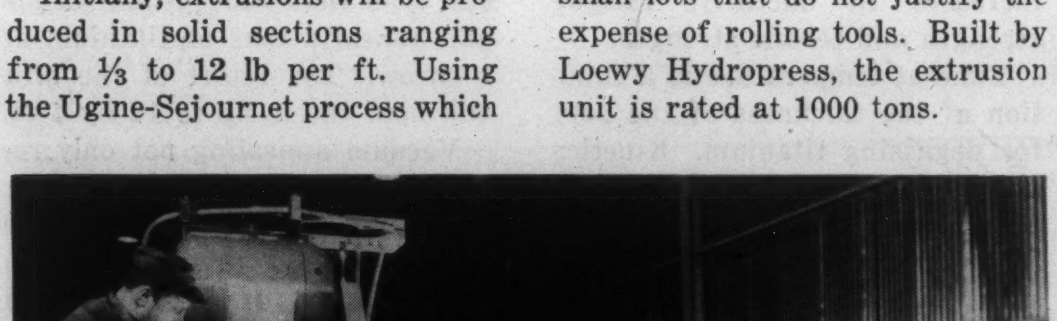
Extrusion die, *made of tungsten chrome hot-worked steel. After each pass, die must be removed and adhering glass is removed by shot blasting.*

Ram advances *toward hot, glass-coated steel billet, positioned automatically in front of billet container.*

New Steel Extrusion Plant

Production of carbon steel extrusions is underway at Jones & Laughlin Steel Corp.'s new plant in Pittsburgh.

Initially, extrusions will be produced in solid sections ranging from ⅓ to 12 lb per ft. Using the Ugine-Sejournet process which lubricates the hot billets with powdered glass, the extrusion plant will turn out complex sections that cannot be rolled, or small lots that do not justify the expense of rolling tools. Built by Loewy Hydropress, the extrusion unit is rated at 1000 tons.



A hot extruded steel section *is straightened on the stretcher detwister.*

Design Tools for New Materials

Designing tools before the materials they will form are available sounds like a cart before the horse situation, but industry is doing it.

Tooling programs in most industries should be considered dynamic and not confined to current practices, declared the chief production engineer of Pratt & Whitney Aircraft Corp. E. P. Bullard III revealed that Pratt & Whitney has 12,000 new tool designs in the process of development, many of them underway in outside plants. A major problem in the aircraft industry is to make a good part the first time, Bullard said, since there is little opportunity for trial and error. As an example of the tooling developments underway, Pratt & Whitney is now designing tools for use with alloys of titanium that are not yet available. Some of the tools are for hot pressing operations even though the extent to which the dies will have to be heated is not yet certain.

More changes

Bullard said that tool designers should take note of the trend of constant change in industry. "In some instances, such as the styling of automotive bodies, there are strong indications that changes are sometimes made simply for their own sake, inasmuch as the public tends to get tired of an old product. In other cases, technological improvement in one line forces a radical change or development in many others. As a result of the demand for so much tooling the need for tool designers and machine designers has constantly increased." More extensive use of unskilled and semiskilled labor for manufacturing increasingly complex products has also caused a significant increase in the need for special tooling, Bullard observed.

Near Production:

Gas Turbines for Passenger Cars

All of the big three automobile manufacturers are knee deep in automobile gas turbine developments. Some recent revelations indicate that a practical, pistonless automobile engine is no longer as far in the future as automotive men have predicted.

When gas turbines appear in passenger cars, the changes they will bring with them will be felt throughout industry. The turbines will require large amounts of high alloy materials for heat resistance, the lubricants required will be different, and the fuel lead-free. Although automobile weight will go down, due to the higher performance of turbine units, braking capacity must rise, since a turbine transmission is simply an air clutch and will not provide motor drag for braking. Compared to today's cars, turbine powered automobiles will use different materials in different configurations in everything but body and interior.

A surface examination of the changes that will occur shows how seriously they will affect automotive parts suppliers. In the power plant, the liquid cooling system is eliminated—there is no longer need for a radiator core. Pistons, connecting rods, complex cast and forged crankshafts and camshafts, carburetor, valves and intake manifold disappear. Many bearing surfaces are eliminated. Replacing the reciprocating assembly is a high-precision, compressor-turbine unit, capable of rotating at 50,000 rpm in hot gas at 1600 F. Bearings withstand speeds greater than 10 times those encountered in standard engines.

The exhaust system has grown as complex as the power unit has become simplified. Replacing a rough-cast system of ductwork is a precision heat exchanger, capable of withstanding thermal shock and the rush of hot, corrosive gases. Replacing the fluid coupling of the transmission is the power turbine, feeding into a chain of ultra high speed reduction gears. In the ignition system, a single spark plug fed by a spark coil replaces the distributor and timing complex. Heavy cast parts—the cylinder heads and engine block—are replaced by a main turbine housing, possibly fabricated from precision castings and machined high temperature alloys. The fuel feed system requires precision metering devices and fuel filters rather than a carburetion unit.

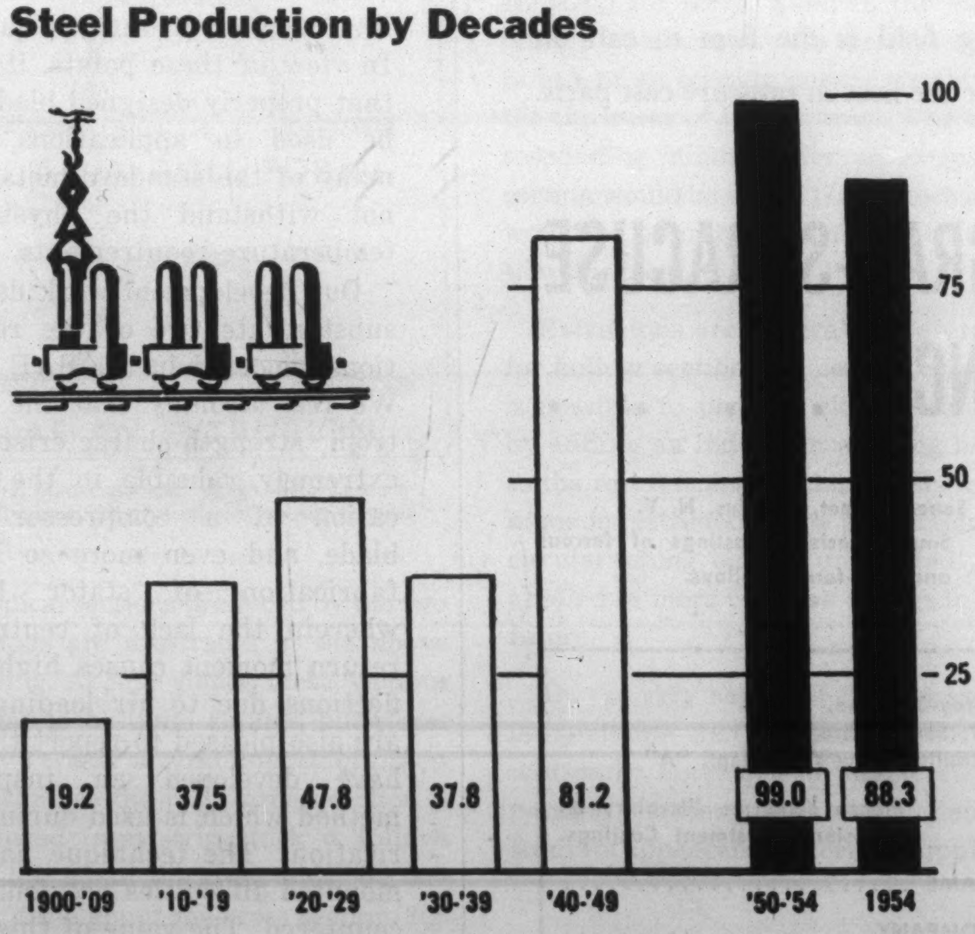
A few months ago these changes looked like a dream in a crystal ball—they were at least 10 or 15 years away. Today, a lot of engineers are revising their estimates—some see turbines in automobiles well before 1960.

Here's how Chrysler, Ford and General Motors are talking:

Ford ■ Last month Dr. W. Chao of Ford Motor Co.'s research division disclosed the first details of Ford's progress in the turbine field. He described a heat exchanger for a regenerative turbine that is 83% efficient at idling speed. For fuel economy and to reduce exhaust volume and temperature, it is necessary to utilize the exhaust heat in a regenerative system that heats the intake air. Efficiencies on the order of that of the Ford heat exchanger allow turbines to operate well within the fuel economy range of current reciprocating engines of equivalent power.

Chrysler ■ Chrysler turbines, probably the closest to actual production, have been demonstrated

(Continued on page 242)



Annual average in 10-yr periods shows steady growth of industry. Figures in millions of net tons of ingots. (American Iron and Steel Institute)

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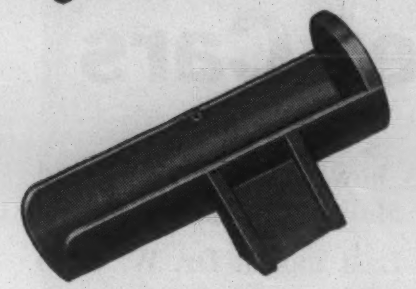

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News Digest

Letters:

To the Editor:

We would like to comment on your resumé of the use of plastics for compressor blades [News Digest, March 1955].

Cincinnati Testing and Research Laboratories has been involved in the development of plastics compressor rotor blades, stator blades, and other jet engine components for approximately seven years. We therefore feel qualified to make certain statements pertaining to both applications and materials. Curtiss-Wright Corporation has recently purchased license rights to all of the Cincinnati Testing Labs' patents, patent applications and "know how" covering various plastics jet engine components.

It is our feeling, based on documented data, that new materials under development in our laboratory will allow plastics compressor blades to be used at the same temperatures that are now contemplated for the known alloys of titanium with a tremendous reduction in weight and a marked improvement in fatigue qualities. In view of these points, it is felt that properly designed blades will be used in applications where many of the standard metals cannot withstand the physical or temperature requirements.

Our development work does not substantiate two of the reservations reported in the SAE paper. We feel strongly that the anisotropic strength characteristics are extremely valuable in the fabrication of a compressor rotor blade, and even more so in the fabrication of stator blades, wherein the lack of centrifugal return moment causes higher deflections due to air loading. We are also pleased to report that we have developed an inspection method which is used during fabrication. The technique has surmounted difficulties previously encountered. The value of this process is borne out in the recent series of tests for a large jet engine manufacturer, in which blades designed to operate at 10,500 rpm were over-spun to 13,800 rpm for a sustained period of time under severe air-buffeting conditions which were intentionally more severe than anticipated engine operating conditions. No failures were encountered.

In our estimation, the use of plastics in aircraft gas turbines will be used basically for engines of long life times. Every engine that we are now studying is for long range personnel-carrying aircraft.

The thermal barrier due to ram air is expected to be troublesome, but the new materials under development indicate that we can reach the same temperature as the contemporary titanium alloys.

The physical qualities of the new plastics materials are such that the material cannot be considered a substitute, but a basic raw material in its own right. In fact, the plastics jet engine component work has been plagued from its very beginning with the thought that we are working on substitute material, and also through our unfortunate use of the word "plastics". We are certain that if the blades had been designated as "glass fiber" blades, or some such material as "Unobtanium", they would be presently seeing wide-spread use. The word "plastics" has implied low strength characteristics such as are found in toys and tooth brushes. The category of materials with which we are concerned in jet engine manufacture is a high strength, extremely fatigue resistant, heat resistant product, which can be manufactured with a minimum of labor and a minimum of critical materials. The many hundreds of hours of engine operation under test stand conditions will attest to our statements.

It is regrettable that security regulations do not allow publication of many of the techniques involved in the fabrication of blades, as we are certain they would be valuable to the reinforced plastics field as a whole.

Elmer P. Warnken
Director
Cincinnati Testing and Research Laboratories

DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 12

ROLL FORMING VS. EXTRUDING

ROLL FORMED SHAPES are produced by passing a continuous strip of material through a series of mating pairs of contoured rolls, each of which bends the strip a little closer to the desired form; the finished shape emerging from the last pair of rolls at a rate of from 75 to 300 feet per minute. The length of the shape is limited only by the length of coil stock available. The finished shape is straight and ready to be sawed to usable lengths as it leaves the roll former.

The process was originally a refinement of the draw bench. By adding a pair of contoured rolls to the bench it was found that the finish and shape of the resulting section could be improved and higher production rates attained. Additional stands of rolls were added until they were accomplishing the entire forming operation.

To produce an extruded shape, a die consisting of a flat steel plate containing an opening of the required shape, is clamped against one end of a container which ordinarily takes the form of a cylinder open at both ends. A cast billet pre-heated to a temperature well within the plastic range is placed in the container and pressure is applied through the open end by the ram of a hydraulic press. Hot metal is slowly forced out through the die opening, assuming the shape of the opening. The rate of extrusion varies from one or two feet per minute to as much as one hundred feet per minute, depending on the composition and temperature of the alloy being extruded. Extruded shapes may be twisted as they come from the extrusion press and must be straightened before they are ready for use. Straightening is ordinarily accomplished by stretching. A variety of other equipment such as roll straighteners, gag presses and detwisters is employed to straighten heat treated sections.

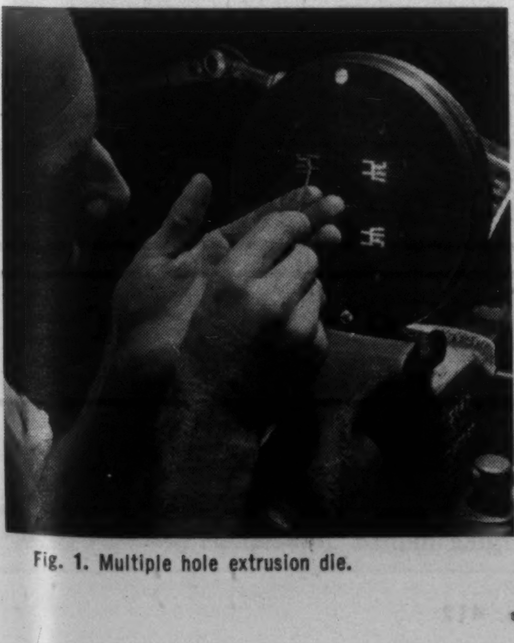

Fig. 1. Multiple hole extrusion die.

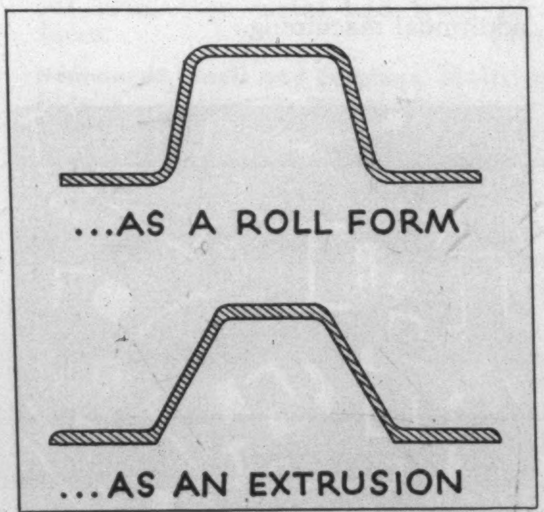

Fig. 2. Trailer side post design. Note more efficient distribution of metal possible with extruded post.

Typical sections produced by the two methods are illustrated in the above drawing. At first glance these sections appear to be quite similar, but closer study reveals several important differences. Since the roll formed section is produced from strip stock it follows that the metal thickness must be uniform throughout the cross section. Extrusions are not subject to such limitations and it is possible to vary the thickness of adjoining sections abruptly through rather wide limits, though the difficulty of obtaining a satisfactory extrusion increases with the disparity in thickness. This fact makes it possible to distribute the metal more efficiently and the stiffness/weight ratio of a properly designed extrusion will equal or exceed that of the corresponding roll formed section.

The thickness of metal which can be extruded is limited by a number of factors having to do with the shape of the section and the alloy to a minimum in the neighborhood of 0.040 in. Roll formed sections can be successfully produced from strip as thin as 0.005 in. and the only restriction imposed by the alloy is that of the minimum corner radius which can be produced without cracking the strip. Even in the most readily formed materials the minimum radius of an outside corner would be the thickness of the material. The corresponding minimum for an extruded section would be about 1/64th inch and would be entirely independent of section thickness.

Extrusions are generally preferred for hollow sections. In certain cases it is possible to produce closed sections by adding an induction welding head to the roll forming machine. This technique is restricted to the production of circular tubing, but will undoubtedly be applied to more complex shapes in the future.

By the very nature of the process, it is inevitable that an extruded section will carry a pattern of fine scratches parallel to its length, which may detract from its appearance in certain applica-

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DESIGNING WITH ALUMINUM Continued

tions. Roll formed sections begin as a strip of highly finished sheet and if properly handled this finish will not be marred. In fact the normal forming operation improves the finish to the extent that the completed product is more or less polished by the surface of the rolls. This fact leads to a preference for roll formed sections for many applications in the truck body, automotive, building and furniture fields and for many sheet metal, aircraft and household articles where the finish of the formed section is important.

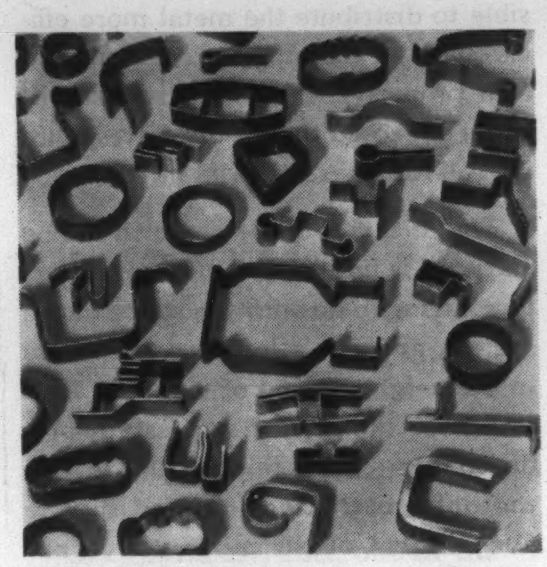

Fig. 3. Roll forming produces an almost unlimited variety of shapes.

Again because they start as sheet, already a fully wrought product, roll formed sections develop higher tensile properties than do extrusions. Because the forming takes place gradually, strain is more uniformly distributed in the roll formed section. Subsequent forming operations required to fabricate the finished product are more easily accomplished than in sections produced by other methods. Where a customer requires a bending or a joggling operation in his finished part, he will find that a cold roll formed part is more easily worked than an extrusion, drawn section or a brake formed part.

It is possible to perform several additional operations by adding suitable attachments to the roll forming machine. By adding a set of coiling rolls at the exit end it is possible to form the section into rings of any reasonable diameter without additional handling operations. Numbering, printing or embossing rolls may be incorporated in the tooling. With embossing rolls, such objects as picture frames, automobile scuff plates, and even jewelry may be formed with the roll design imprinted in the metal.

Rolled sections with inserts of wood, fabric, wire, powdered material, paper and any other substance which can be fed to the machine continuously, are easily formed.

While extrusions do not lend themselves to the application of a repeated pattern while being produced as do the roll formed sections, they may be easily and economically designed to meet specific product requirements. It is easy to add metal from which ribs, lugs and pads may be produced with little or no additional machining.

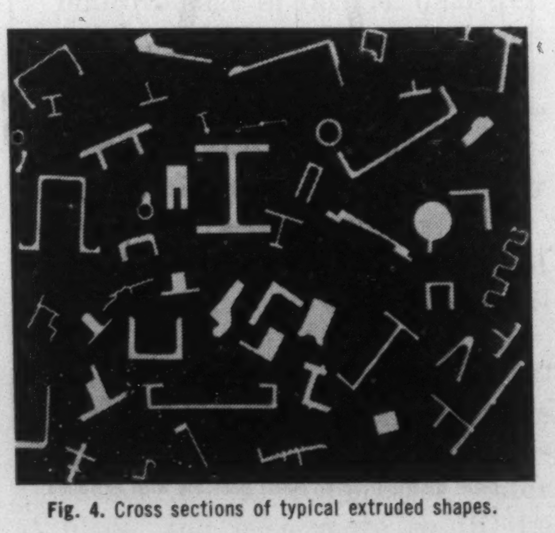

Fig. 4. Cross sections of typical extruded shapes.

The contoured rolls required for the production of cold roll formed shapes are relatively expensive since they require a considerable amount of hand work to match the male and female rolls in each pair exactly. The number of pairs or "stands" of rolls required to produce a given section is directly proportional to the complexity of the section. As many as thirty stands have been used on an especially intricate shape, although this must be considered unusual. Most sections may be formed on machines designed for a maximum of sixteen stands. Once the dies have been made and adjusted, production proceeds at a relatively high rate.

In contrast, extrusion dies are simple and much less costly but production is generally slower. The choice of production method will then be considerably influenced by the total quantity and rate of production which is desired. Relatively long runs are required to amortize the cost of roll dies.

When all properties of the two types of section are considered, it becomes apparent that the title of this article is somewhat misleading. "Roll Forming *and* Extruding" would be more appropriate for each has its special field of application in which the other simply cannot do the job as well.

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Manufacturers' Literature

Zinc. American Zinc Institute. Illustrated folder on the importance of zinc in brass production. (17)

Precision Castings. Atlantic Casting & Engineering Corp., 12 pp, illus. How to obtain nonferrous castings cast to ordinary machining tolerances. Describes process and gives alloy specifications. (18)

Coated Abrasives. Behr-Manning Corp., 60 pp, illus. Compilation of technical papers on coated abrasive grinding and polishing techniques. Covers coated abrasives theory and practice, contour polishing and grinding, part sizing and deburring, etc. (19)

Metallurgical Testing Equipment. Buehler Ltd., 12 pp, illus. Describes metallurgical specimen mount presses. (20)

Steel Cutting Carbides. Carboloy Dept., General Electric Co., 16 pp, illus, No. GT-305. Revised catalog covers prices and specifications on standard tools and blanks in 300-series steel cutting carbides. Includes throw-away inserts and mechanically held blanks. (21)

Stainless Tubing and Pipe. Carpenter Steel Co., 4 pp, illus. Describes corrosion and oxidation resistant steel tubing. Outlines uses and gives size range of tubing and pipe available. (22)

Reinforced Fiberglass Parts. Clearfield Plastics, Inc., 22 pp, illus. Discusses company's facilities for producing molded contoured parts. Suggests design and specification techniques. (23)

Metallic Abrasives. Cleveland Metal Abrasive Co., 16 pp, illus. Discusses three types of metallic abrasives and selection of abrasion method. (24)

Lead Treated Steel. Copperweld Steel Co., Steel Div., 8 pp, illus. Mechanical properties and applications of lead treated steels. (25)

Steel Sheets and Wire. Continental Steel Corp., 20 pp, illus. Contains sizes, tempers, shapes and finishes of wire available and describes types of steel sheet in stock. (26)

Industrial Glassware. Corning Glass Works, 8 pp, illus, No. B-91. Describes silica glass with thermal shock resistance and chemical stability. Applications include stove top units, heat lamp bulbs and laboratory equipment. (27)

Zinc Phosphate Coatings. Cowles Chemical Co., 4 pp. Properties of amorphous and crystalline non-sludging zinc phosphate coatings. (28)

Cast Alloy Cutting Tools. Crobalt, Inc., 8 pp, illus, No. 55. Lists tools available, including solid square, rectangular and round tool bits, solid cutoff blades and inserts for vertical tool holders. (29)

Alloy Steel Castings. Electric Steel Foundry Co., 10 pp, illus, No. 1. Discusses extra low carbon cast stainless alloys, their chemical composition, typical physical properties and applications. (30)

Metal Strippers. Enthone, Inc., 4 pp, illus. Selective metal strippers for removal of plated coatings, excess solder, and metal smuts. (31)

Spray Painting Equipment. Finish Engineering Co., Inc., 16 pp, illus. Describes pressure formed spray painting masks and auxiliary equipment. Price list included. (32)

Fasteners. General Tire & Rubber Co., illus, folder. Self-mounting fasteners for shock-mounting metal, plastic and glass panels and components. (33)

Metal Cleaning. Graymills Corp., 8 pp, illus. Cold solvent type metal cleaning equipment described. (34)

Adhesives and Coatings. Houghton Laboratories, Inc., 96 pp. Bound volume of technical bulletins and price lists covering adhesives, coatings and plastics materials. (35)

Steel Castings. International Nickel Co., Inc., 16 pp, illus. Information and case histories on use of sand, centrifugal and precision investment castings for wear, corrosion and temperature resistant applications. (36)

Sheet and Plate Fabrication. Kirk & Blum Mfg. Co., 38 pp, illus. Describes facilities and equipment used in production of metal sheet and plate. (37)

Die Castings. Lester Castings, Inc., 4 pp, illus. Facilities for die casting. (38)

Reinforced Plastic Tooling. Marblette Corp., 18 pp, illus. Manual covering use of laminated epoxy resins in plastics tooling. (39)

Chemical Resistant Coatings. McDougall-Butler Co., Inc., 4 pp, illus. Describes chemical resistant coating used without primer on metal and wood surfaces. (40)

Hammered Steels and Forgings. McInnes Steel Co. Folder on manufacturing facilities for forged and hammer formed steel parts. (41)

Vapor Degreasing. Metalwash Machinery Corp., 12 pp, illus. Outlines principle of vapor degreasing and various types of equipment. (42)

Calibrating Machine. Morehouse Machine Co., 4 pp, illus, No. 115. Describes operation and application of company's calibrating machine for load cells. (43)

Spectrograph. National Spectrographic Sales Corp., 8 pp, illus. Spectrographic equipment and accessories. (44)

Nitriding. Nitralloy Corp., 50 pp, illus. Explains nitriding process and gives compositions, mechanical properties and case hardening capabilities of four alloy steels. (45)

Zinc Phosphate Coatings. Oakite Products, Inc., 10 pp, illus. Describes corrosion-resistant zinc phosphate coating for steel, which improves adhesion between paint and metal. (46)

Carbon Parts. Ohio Carbon Co., 4 pp, illus. Gives thermal, mechanical and electro-mechanical properties of company's carbon parts. (47)

Industrial Tape. Polyken Products, 4 pp. Sixteen pressure-sensitive tape samples with accompanying specifications and properties. Explains basic industrial tape applications. (48)

Wire Cloth. Reynolds Wire Div., 64 pp, illus. Describes manufacture, testing, and types of wire cloth. Specifications and applications given. (49)

Plastic Foams. Rezolin, Inc., 4 pp, illus, No. 104. Foamable plastic for die cores, filled structures, etc. (50)

Molded Plastics. Richardson Co., 12 pp, illus. Describes types and grades of laminated and molded plastics. Applications given. (51)

Centrifugal Cylindrical Castings. Sandusky Foundry & Machine Co., 4 pp, illus. Announces extended range of casting facilities, including both ferrous and nonferrous centrifugal cylindrical castings. (52)

Steel and Stainless Steel Tubing. Standard Tube Co., 8 pp, illus. Gives specifications and applications for pipe tubing, welded steel tubing and pressure tubing. (53)

Forging and Weldment Facilities. Struthers Wells Corp., 16 pp, illus. Presents typical products fabricated by company's three plants. (54)

Precision Ceramics. Stupakoff Ceramic & Mfg. Co., 4 pp, illus, No. 301. Describes production methods and techniques for manufacturing ceramic parts and metallized ceramic assemblies to close dimensional tolerances. (55)

Foundry Products Superior Steel & Malleable Castings Co., 25 pp, illus. Gives 25 case histories showing products before and after re-designing. (56)

Heat Treating. Swift Industrial Chemical Co., 3 pp, No. MD-1. Data sheets showing conventional temperatures used for hardening, annealing and carburizing SAE steels and approximate hardness resulting from treatments. (57)

Preheating Temperatures. Tempil Corp. Chart lists recommended preheat temperatures for 79 commonly used metals and alloys. (58)

Stampings. Variety Machine & Stamping Co., 4 pp, illus. Describes plant's facilities for, and variety of stampings. (59)

Stampings. Well Specialty Co., Inc., 22 pp, illus. Facilities for stampings, dies and engineering service. (60)

Industrial Fibers and Textiles. Wellington Sears Co., 26 pp, illus. Properties of industrial textile fibers, including cotton, rayon, acetate, nylon, acrylic, polyester, glass, vinyl and protein. Defines yarn designations, basic weaves and variations as used in fabrics. How fabrics are selected for use with rubber; as coated fabrics; in laminated plastics; for filtration purposes; and other applications. (239)

Welding Process. Westinghouse Electric Corp., 7 pp, No. B-6525. Describes performance and applications of consumable electrode inert gas welding process. (61)

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Hot Extrusions. Allegheny Ludlum Steel Corp., 4 pp, ill., No. SS-41. Hot extruded forms of stainless, tool steel and high temperature alloys. Stresses low scrap, minimum machining, low die cost for special sections. (62)

Metal Powder Parts. American Sinterings Div. of Engineered Plastics, Inc., 4 pp, ill. Facilities for fabrication of ferrous or nonferrous metal powder parts. (63)

Carbonyl Iron Powder. Antara Chemicals Div. of General Dyestuff Corp., 31 pp, ill. Description, use and formulation of high purity carbonyl iron powders for electronic and powder metallurgy use. (66)

Precision Castings. Austenal Laboratories, Inc., Microcast Div., 16 pp, ill. Describes Microcast Process for manufacture of precision cast parts, including specifications and explanation. (67)

Steel Tubing. Avon Tube Div., 12 pp, ill. Welded steel tubing with high tensile strength and ductility. Fabrication service provided. (68)

Small Swaged Parts. The Bead Chain Mfg. Co. Describes Multi-Swage process for swaging small metal parts from flat stock. Shows advantages and applications of method. (69)

Low-Alloy Steel. Bethlehem Steel Co., 66 pp, ill, No. 353. Properties and features of Mayari*R steel for use in applications requiring high strength and good wear and corrosion resistance. (70)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrications, specifications. (71)

Duplex Tubing. Bridgeport Brass Co., 14 pp, ill, No. 1954. Explains the use of Duplex tubes for heat exchangers and condensers in which internal and external corrosion conditions differ. (72)

Steel Tubing. Bundy Tubing Corp., ill. Steel tubing for various industrial applications. (73)

Stainless Steel Heads. G. O. Carlson, Inc. Various lists of typical uses and dies available. Price lists included. (240)

Cast Iron. Carondelet Foundry Co., 4 pp, ill. Discusses a variety of modern cast irons controlled and alloyed for industrial requirements. (74)

Specialty Steels. Crucible Steel Co. of America, 32 pp, ill, No. TM9. Information on cold rolled specialties, including stainless, alloy and carbon spring steels. (75)

Gray Iron Castings. Dostal Foundry Machine Co. Permanent mold gray iron casting facilities. (76)

Iron Powder. Easton Metal Powder Co., Inc., 5 pp, ill. Specifications for designing for Ferroflame "A" iron powder. (77)

Conveyor Belt Castings. Electro-Alloys Div., American Brake Shoe Co., 6 pp, ill, No. T-241. Folder gives design details and applications for Thermalloy conveyor belts. Emphasizes resistance to "crank-shafting." (78)

Stainless Steel. Firth Sterling, Inc., 2 pp, No. 25-150. Application data for corrosion and wear resistance. (79)

Gray Iron. Gray Iron Founders' Society, Inc., Data Sheet and 12 pp booklet. Data sheet summarizes gray iron specifications. Booklet contains articles on how and when to use gray iron, and its adaptability for casting. (80)

Perforated Materials. The Harrington & King Perforating Co., No. 62. Catalog gives data on fabrication methods, how to order, types of perforation and uses of perforated materials. (81)

Sponge Iron Powder. Hoeganaes Sponge Iron Corp., 12 pp, ill. Properties of Swedish sponge iron powder. (82)

Precision Casting. Howard Foundry Co., 6 pp. Characteristics and physical properties of ductile iron in comparison with other metals and a reprint of an article entitled "Design of Precision Cast Parts". (83)

Welded Tubing. Jones & Laughlin Steel Corp., 16 pp, ill. Applications of electrically welded steel tubing, bending and finishing data, tolerances, weight-per-foot tables and other information useful in selecting tubing. (84)

Pressed Parts. Lenape Hydraulic Pressing and Forging Co. Catalog shows numerous parts press formed by this company illustrating the kinds of jobs this firm can perform. (85)

Malleable Castings. The Malleable Founders' Society, 8 pp, ill, No. 47. Analysis of good practice in tolerances and specifications of malleable castings. (86)

Quality Iron Castings. Meehanite Metal Corp., 48 pp, ill, No. 43. Contains 64 illustrations of specific industrial applications of Meehanite castings. (87)

Metal Powder Parts. Metal Powder Products, Inc., 4 pp, ill. Features a variety of applications for iron, iron-copper, and bronze sinterings produced by this company. (88)

Threaded Stampings. Mohawk Mfg. Co., 2 pp, No. 851. Illustrates variety of products produced by Mohawk's stamping processes, guaranteeing uniform threaded parts with uniformly threaded holes. (89)

Seamless Steel Tubing. National Tube Div., U. S. Steel Co. Explains time- and cost-cutting fabricating applications of this company's Shelby seamless tubing. (90)

Steel Tubing. Rochester Products Div., General Motors, 12 pp, ill, No. 271. Features typical applications of GM tubing made in both single and double walls of steel. (91)

Roll Formed Shapes. Roll Formed Products, 24 pp, ill, No. 1053. Shows production procedures and advancements in roll forming shapes from ferrous and nonferrous metals. (92)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (93)

Steel Tubing. Summerill Tubing Co., Div. Columbia Steel and Shafting Co., 8 pp, ill. Cold drawn steel tubing for hydraulic applications. (94)

Deep-Drawn Shapes. Roland Teiner Co., 8 pp, ill. Reprint illustrates the many deep-drawn simple and intricate shapes produced by the new Hydroform process. (95)

Cold Rolled Steel. Thomas Strip Div., Pittsburgh Steel Co., 50 pp. Complete table on pound for lineal foot in weight for cold rolled strip steel in widths of ¼ to 24 in., thicknesses from 0.001 to 0.2757. (96)

Small Precision Metal Parts. Torrington Co., 4 pp, ill. Illustrates the various small precision metal parts custom-made by the Specialties Div. of Torrington. (97)

Steels. Timken Roller Bearing Co., Steel & Tube Div., Canton, Ohio. Complete catalog of steels produced by this company. Request on company letterhead direct from Timken.

Steel Castings. Unitcast Corp., ill, No. 649-A. Discusses this company's testing facilities for insuring high quality production of steel castings. (98)

Prealloyed Steel Powder. Vanadium-Alloys Steel Corp., 12 pp, ill, No. 3. The technology of prealloyed steel powders, their properties, production and use. (99)

Pipe and Tubing. The Wallingford Steel Co., 8 pp, ill. Stainless, carbon and alloy steel tubing for ornamental, mechanical, pressure, sanitary and aircraft use in size range from ¼-in. to 3-in. O.D. (100)

Stainless Steel Sheet and Strip. Washington Steel Corp., 4 pp. Includes types, uses, physical properties and specifications of MicoRold stainless steel sheet and strip. (101)

Stainless Steel Castings. Waukesha Foundry Co., 4 pp, ill, No. WF-5. Shows facilities of this company for producing any hard-to-shape type of stainless steel castings. (102)

Continuous Weld Pipe. Youngstown Sheet and Tube Co., 2 pp. Folder gives complete data on Yoloy continuous weld standard pipe and line pipe, and its corrosion resistance. (103)

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High Voltage Conductor. Aluminum Co. of America, 16 pp, ill. "Alcoa Expanded ACSR". New conductor cable for 300 KV and above. Describes cable construction, line erection techniques and special accessories. (64)

Engineering Bronzes. American Crucible Products Co., 12 pp, ill. Includes complete data on facilities, technical information, case histories and applications of Promet bronzes. (104)

Bronze Casting Alloys. American Manganese Bronze Co., 50 pp, ill. Revised edition gives composition, characteristics and applications of the principal copper alloys used to make castings. (105)

Cast Aluminum. American Smelting & Refining Co., 20 pp, ill. No. 165. "Practical Help in the Casting of Aluminum Alloys". Deals with the effects of moisture, shrinkage, dross, pouring temperature and test bars. (65)

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Magnesium. Brooks & Perkins, Inc., 8 pp, ill. Describes facilities and services of this company for fabricating magnesium. (106)

Die Cast Parts. Dollin Corp. Bulletin describes advantages of using this company's facilities for production of small zinc or aluminum precision cast parts. (107)

Rings. Dresser Mfg. Div., 4 pp, illus. Heavy industrial equipment fabrication from welded rings. (108)

Stampings. Federal Tool & Mfg. Co., 4 pp, ill. Short run, close tolerance stamping with low cost dies. (109)

Printed Circuits. Formica Co., 12 pp, ill, No. 457. Describes copper clad printed circuits with instructions for construction and applications. (110)

Contact Rivets. Gibson Electric Co., 6 pp, ill, No. C-521. Description and specifications of a complete line of Gibson electrical contact rivets. (111)

Metal Stampings. Geometric Stamping Co., 4 pp, ill. Suggestions for cost savings through conversion from castings to stampings. (112)

Investment Castings. Gray - Syracuse, Inc., 4 pp, ill. Parts of precision cast brass bronze, beryllium copper and steel. (113)

Copper and Brass Tubing. H & H Tube & Mfg. Co. Describes a complete line of seamless braze and lock seam copper and brass tubing. (114)

High Temperature Alloys. Haynes Stellite Div. "Haynes Alloys for High Temperature Service" provides detailed tables and charts on their properties and heat treatment. (115)

Laminated Metals. Improved Seamless Wire Co., Inc., 6 pp, ill. Describes the importance and applications of laminated metals to modern industry. (116)

Heat Treating Nickel Alloys. International Nickel Co., Inc., 16 pp, ill, No. A-115. How to increase usefulness of cast irons and improve properties by alloying and heat treating. Includes treatment of nickel cast iron, plain cast iron, nickel-chromium cast iron, nickel-chromium-molybdenum cast iron. (117)

Bronze Parts. Johnson Bronze Co., 106 pp, ill, No. 530. Catalog listing quality bearings, bar bronze, babbitt and powder metallurgy products. (118)

Aluminum Alloys. Kaiser Aluminum & Chemical Sales, Inc., 24 pp, ill. Data on forms, properties, applications and availability of aluminum alloys. Copious reference tables. (119)

Die Castings. Litemetal DiCast, Inc., 12 pp, ill. How to select best light metal for die casting. Shows facilities for producing light metal pressure die castings. (120)

Magnesium. Magline Inc., 8 pp, ill. Facilities for fabricating magnesium and producing sand castings. (121)

Tin. The Malayan Tin Bureau. "Tin News," a monthly publication of the Malayan Tin Bureau, reviews market situation, tin uses and political developments affecting the supply of tin. (122)

Cored Forgings. National Cored Forgings Co., Inc., 8 pp, ill. Advantages and typical examples of cored forgings made of brass, bronze, copper and other nonferrous metals. (123)

Brass Metal Powder Parts. New Jersey Zinc Co., 4 pp, ill, No. 9. Powder-metal application case histories for lock cylinders, radio transmitter parts and instrument clamps. (124)

Precious Metal Wire. The J. M. Ney Co., 2 pp. Technical data on advantages of using Ney-Oro 6, precious metal wire for pivots in instrument bearings. (125)

Precision Castings. Ohio Precision Castings Inc., 12 pp, ill. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium-copper plaster mold castings. (126)

Die Castings. Paramount Die Castings Co., 4 pp, ill. Describes facilities and services and shows representative aluminum, magnesium and zinc castings. (127)

Die Castings. Precision Castings Co., Inc., 24 pp, ill. Describes company's integrated facilities for quantity production of aluminum, magnesium and zinc die castings. (128)

Bushings. Randall Graphite Bearings, Inc., 12 pp, ill, No. 100. Complete price list of bronze bushings and specially grooved bushings; specifications of bored and solid bronze bars. (129)

Aluminum Extrusions. Revere Copper & Brass Inc., 28 pp, ill. Features a simplified easy-to-follow section on standard tolerances of aluminum extruded shapes, presented in table form. (130)

Aluminum Mill Products Design. Reynolds Metals Co., 12 pp, ill. Condensed information on Reynolds aluminum mill products. (131)

Precision Investment Casting. Alexander Saunders & Co., 14 pp, ill. Discussion of advantages of this process in comparison with conventional methods of production, techniques, equipment and supplies needed. (132)

Aluminum Strip. Scovill Mfg. Co., 20 pp, ill. Physical characteristics, temperature designations, weights and fabricating data for aluminum alloy strip. (133)

Precision Casting. Thompson Products, Inc., Metallurgical Products Div., 8 pp, ill, No. MP-53-1. Discusses the Intricast process of precision casting any castable metal or alloy. (134)

Screw Machine Products. Westfield Metal Products Co., Inc., 4 pp, ill. Describes facilities for the production of a variety of machines, nuts and screw machine products. (135)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (136)

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Silicone Rubber. Acushnet Process Co., 8 pp, ill, No. B. Describes method of custom-compounding silicone rubber. Gives property ratings, molding techniques, mold design and design specifications. (137)

Plastic Molding. Ackerman Plastic Molding Div., 4 pp, ill. Long run production of plastic parts by compression of plunger molding. (138)

Felt Parts. American Felt Co., folder, ill. Describes custom-made cut felt parts and applications, including separating, protecting, sealing, polishing and insulation. (139)

Extruded Plastics. Anchor Plastics Co., 12 pp, ill. Applications of thermoplastic rods, tubes and shapes. Summary of properties of plastics materials with usage table. (140)

Gasket Materials. Armstrong Cork Co., 24 pp, ill. Complete data on various cork and rubber gasket materials made to meet government specifications. (141)

Gaskets, Packings, Etc. Auburn Mfg. Co., 3 pp, ill. Discusses the various products produced by this company, including gaskets, packings, washers, spacers, seals, shims and bushings. (142)

Closed-Cell Sponge Rubber. Automotive Rubber Co., Inc., 4 pp, ill. Describes insulating and shock-absorbent synthetic rubber. Specifications and chemical resistance table. (143)

Molding Compounds, Resins and Cements. The Borden Co., Chemical Div., 8 pp, ill, No. 10M. General properties and uses of Durite specially prepared phenolic molding compounds, resins and cements. (144)

Ceramic Coating. California Metal Enameling Co., 8 pp, ill. Ceramic coatings for metals for high temperature service. Includes sample of ceramic coated 0.001-in. stainless steel foil. (145)

Plastic Pipe. Carlon Products Corp., 4 pp, ill. Contains factual informative answers to most frequently asked questions about carbon flexible plastic pipe and carbon rigid pipe. (146)

Optical Plastic Sheet. Cast Optics Corp., 4 pp, ill. Applications of optical plastic sheet cast to close tolerances. (241)

Polyester Resins. Celanese Corp. of America, Plastics Div., 22 pp, ill. Provides background information, properties, curing processes, formulations and instructions for laminating, casting, spraying and impregnating with the MR series, low pressure, liquid-thermosetting resins. (147)

Silicone Rubber. Dow Corning Corp., 4 pp. Technical data sheet 9-334. Contains information needed to select the proper Silastic stock or paste for maximum performance. (148)

Black Oxide Finish. Du-Lite Chemical Corp. Information on Du-Lite finishes for any steel blackening problem. Also gives information on Du-Lite cleaner, strippers, burnishing compounds, etc. (149)

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Synthetic Rubber. E. I. du Pont de Nemours & Co., Inc., Rubber Chemicals Dept., 8 pp, illus., No. 62. Discusses thermal properties of rubber and precautions to be taken in precision molding and heat treating (150)

Teflon. E. I. du Pont de Nemours & Co., Inc., 12 pp. Third revision of du Pont technical bulletin on tetrafluoroethylene resin finishes. Lists 17 new applications and discusses various finishing systems. (151)

Felt. Felters Co., 16 pp. "Felters Design Book" offers numerous ideas and technical data about felt. (152)

Thermoplastic Resins. Firestone Plastics Co., Div. of Firestone Tire & Rubber Co., 20 pp, ill. Properties and use of Exon vinyl resins. Describes technical service facilities available. (153)

Polystyrene Sheet. Gilman Bros. Co., 4 pp, ill. High impact polystyrene sheet for vacuum forming. Has five times the strength of general-purpose sheet. (154)

Insulating Sheet. Glastic Corp., ill. Property data and comparison charts on Glastic MM, Fiberglas reinforced laminate with high strength and heat resistance for electrical insulation. (155)

Metallized Plastic Sheeting. Gomar Mfg. Co., Inc., 3 pp. Describes vacuum forming process and applications for metallized thermoplastic sheeting. (156)

Plastics Stamping. B. F. Goodrich Chemical Co., 7 pp, ill. How to form rigid vinyl plastic parts with metal stamping presses and Geon resins. (157)

O-Rings. Goshen Rubber Co., Inc., 14 pp, ill. Tells where and how to use O-rings in engineering applications. Lists sizes, groove dimensions and compounds for all types of O-ring seals. (158)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill, No. 108. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (159)

Insulation Hardboard. Great American Industries, Inc., Rubatex Div., 16 pp, ill. Design data for building insulation applications of Rubatex Hardboard (expanded synthetic rubber compound). (160)

Polyvinyl Chloride Resin. H. N. Hartwell & Son, Inc., 8 pp, ill. Sheet, bar stock list of nonplasticized polyvinyl chloride. (161)

Plastics. Heil Process Equipment Corp., 4 pp, ill, Vol. 4, No. 1. Suggests applications for Rigidon, a glass-reinforced plastic; Rigidin, a rigid vinyl plastic; and Rigidene, a polyethylene plastic. (162)

Fluorocarbon Plastics. M. W. Kellogg Co., 16 pp, ill. Index of processors and converters, manufactured items and services connected with the production of Kel-F parts and forms. (163)

Expanded Plastics. Koppers Co., Inc., 26 pp, ill. How to mold foamed polystyrene parts. Properties, data sheet and applications given. (164)

Glass. Lancaster Lens Co., 8 pp, ill. Twenty-one case histories of a wide variety of glass part applications. (165)

Glass. Libbey-Owens-Ford Glass Co., 8 pp, ill. Glass in product and engineering design. (166)

Electrical Insulation. Louthan Mfg. Co., 13 pp, ill, No. 49-E. Uses and specifications of Louthan insulations in mechanical, electrical, thermal and electronic fields. (167)

Refractory Porcelain. McDanel Refractory Porcelain Co., 36 pp, ill. Catalog of high temperature porcelain products with physical, mechanical and electrical properties. (168)

Plastic Molding. P. R. Mallory Plastics, Inc., 4 pp, ill. Complete production facilities for large scale production of custom-molded parts from design to finishing and assembly. (169)

Cathodic Protection. National Carbon Co., 12 pp, ill, No. S-6500. How to mitigate corrosion of underground and submerged metal structures by the application of an impressed current cathodic protection system using graphite anodes. (170)

Plastic Resins and Compounds. Naugatuck Chemical Div., 8 pp, ill. Vinyl, polyester and elastomeric resins and compounds, applications, properties and processing. (171)

Electrochemically Refined Materials. Norton Co. Lists complete line of electrochemically refined refractory materials for industry. (172)

Fiber Glass. Pittsburgh Plate Glass Co., 4 pp, ill. Lists advantages of using fine glass fiber mat for sound heat insulation application. (173)

Resins for Shell Molding. Plastics Engineering Co., 18 pp, ill. Thoughtful analysis of shell molding process with description of resins developed for manufacturing shell molds. (174)

Precision Molded Thermoplastics. Plastic Molded Parts, Inc., 6 pp. Facilities available for Zytel and other thermoplastic precision moldings. (175)

Nylon Tubing. Polymer Corp., 6 pp, illus. Describes 1000- and 2500-psi pressure tubing that is corrosion resistant and has wide temperature range. (176)

Styrene Resins. Reichhold Chemicals Inc., Technical Bulletins Nos. 1. 2. 3, 4 and 5. Applications, characteristics, catalysis and mixing recommendations of Polylite polyester resins. (177)

Fluorocarbon Plastics. Resistoflex Corp. Fluoroflex-T assures the ideal, low loss insulation for uhf and microwave applications and serviceability through temperatures from —90 to 500 F. (178)

Gasket Sheeting. Rogers Corp., 4 pp, ill. Describes a line of asbestos-elastomer material. (179)

Rubber Parts. Stalwart Rubber Co.. 16 pp, ill, No. 51SR-1. Describes applications and fabrication of rubber compounds, designed to resist temperature, abrasion, chemicals and weathering. (180)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on pages 67 and 68

Rubber Parts. Stillman Rubber Co., 24 pp, ill. Facilities and products of custom molding company. (243)

Molded and Extruded Rubber Parts. Tyer Rubber Co., 8 pp, ill, No. 1P52. Detailed information on various types of molded and extruded parts of natural and synthetic rubber. (181)

Plastisol. United Chromium Inc., 4 pp, ill. Physical, chemical properties of Unichrome plastisol compounds used for coating, casting or molding. (182)

Carbon-Graphite Parts. U. S. Graphite Co., 68 pp, ill, No. G-49. Properties, chemical resistance, limitations, assembly information, design aids and 60 applications of Graphitar. (183)

Synthetic Rubber Sheet and Roll Goods. Acadia Div., Western Felt Works, 2 pp, samples. Ten samples clipped to chart of physical specifications. Durometer, tensile and elongation characteristics. (184)

Laminated Plastics. Westinghouse Electric Corp., 50 pp. Catalog on industrial Micarta covering all grades and forms in which Micarta is supplied, and the chemical, mechanical and electrical properties of each. Machining data gives fabrication information. (185)

Finishes • Cleaning and Finishing

Sodium Nitrite. Allied Chemical & Dye Corp., Solvay Process Div., No. SP-23A. Describes uses of sodium nitrite for protecting metal surfaces against rust or corrosion. (186)

Chromate Conversion Coatings. Allied Research Products Inc., 4 pp, ill, No. 8. Complete data on the basic characteristics of Iridite chromate conversion coatings, and their functions on various metals. (187)

Cleaning and Finishing Media. Almco Div., Queen Stove Works, Inc., 10 pp, ill. Features and applications of Supersheen Abrasive Chips and Compounds for barrel finishing and cleaning. Also data on finishing machines. (242)

Molybdenum Disulfide as a Lubricant. The Alpha Corp., 4 pp, ill. Reprint discusses the properties and uses of pure molybdenum disulfide as a lubricant. (188)

Plating Tanks. The Chemical Corp., 4 pp, ill. Data sheets on chemical resistance of resin-bonded Fiberglas plating tanks, their specifications and advantages. (189)

Spray Painting. Conforming Matrix Corp., 5 pp, ill. Gives description, uses, and advantages of this firm's spraying masks, mask washing machine, and spray painting equipment. (190)

High Vacuum Equipment. Consolidated Vacuum Corp. Price list of high vacuum equipment and accessories. (191)

Wet-Blasting. The Cro-Plate Co., Inc., 8 pp, ill. Equipment for two-speed wet-blasting for finishing metal parts. (192)

Metal Cleaning and Processing. Detrex Corp., 8 pp, ill. Industrial washers for

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Manufacturers' Literature

a variety of cleaning operations. (193)

Industrial Cleaning. Du Bois Co. Metal cleaning chart with folder on three-stage spray cleaning and a spray booth maintenance check chart. (194)

Chemical Plating. General American Transportation Corp. Large illustrated folder. Description of Kanigen, a new type of nickel plating process requiring no electrical equipment. (195)

Protective Coatings. Industrial Metal Protectives, Inc., 8 pp, ill, No. Z-853. Zincilate self-protecting anti-corrosion coatings for metal parts and products. (196)

Insulating Varnish. Irvington Varnish & Insulator Co. General catalog on complete lines of insulating varnishes. Also contains a section "How to Use Insulating Varnishes." (197)

Finishing Equipment. The Murray-Way Corp. Catalog describes full line of this firm's automatic polishing, buffing and grinding equipment. (198)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (199)

Tar-Base Protective Coatings. Pittsburgh Coke & Chemical Co., Protective Coatings Div. Five bulletins give detailed information concerning Pitt Chem 100 Series of tar-base protective coatings. (200)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Corrosion Resistant Coating. Specialty Coatings Inc., Div. of Thompson & Co., 6 pp, ill. Examples of how Vinsynite Pretreatment was used in finishing six different types of metal products for good paint adhesion and corrosion resistance. (201)

Heat Treating • Heating

Electric Sintering Furnaces. The Electric Furnace Co., 4 pp, ill. Descriptions of nine EF sintering furnaces. (202)

Atmosphere Generators. Gas Atmospheres Inc., 6 pp, ill, bulletins N-452 and 1-552. Brochures describing the features and applications of insert atmosphere generators and nitrogen atmosphere generators. (203)

Heat Treating Furnaces. Hevi Duty Electric Co., 8 pp, ill, No. 653. Describes furnaces for annealing, stress relieving, nitriding, etc. (204)

Electric Heating Elements. Holcroft & Co., 4 pp, ill. Describes four types of electric heating elements and their mounting methods. Classifies heat treat furnaces according to stock handling method. (205)

Tubular Furnaces. Marshall Products Co., 4 pp, ill. Discusses both the creep test and tensile test models of Marshall tubular furnaces, as well as control panels and radial brackets. Includes specifications. (206)

Hole Quencher. Palmer Mfg. Co., 4 pp, ill. Features advantages of using the I. D. Hole-Quencher for case hardening holes seven times faster. (207)

Electric Furnaces. Pereny Equipment Co., 3 pp, ill, No. 4A. Booklet tells advantages and illustrates typical group of furnaces and kilns and their uses. (208)

Air Compressors. The Spencer Turbine Co., 12 pp, ill, No. 126-A. Performance curves, capacity tables and detailed descriptions of Turbo compressors for use in gas or oil fired heat treating equipment. (209)

Quenching Oil. Sun Oil Co., 2 pp, No. 29. Describes oil of high thermal stability and high boiling range. For quenching systems requiring a high flash-point and for bright quenching from controlled atmosphere furnaces. (210)

Cold Treatment Equipment. Revco Inc., 2 pp, ill. Describes cold treating cabinets for seasoning gages and precision tools, for testing, for shrink fits, and for aircraft rivet applications. (211)

Heat Treating Furnaces. Industrial Heating Dept., Westinghouse Electric Corp., 38 pp, ill, No. B-5459. Complete description of Westinghouse furnaces—large and small, gas and electric. (212)

Heating Units. Edwin L. Wiegand Co., No. 50. Catalog describes this company's industrial heating units, giving specifications and features. (213)

Welding • Joining

Bronze Electrodes. Ampco Metal Inc., 24 pp, ill, No. W17. Describes complete line of products for use with metal-arc, tungsten-arc, carbon-arc, submerged-arc and inert-arc consumable electrode process. (214)

Bonding Resins. Ciba Co., 4 pp, ill. Properties of new group of resins, their applications as adhesives for metals and non-metallic moldings and coatings. (215)

Rivet-Type Fasteners. B. F. Goodrich Co., Rivnut Div. Cardboard "demonstrator" illustrates working principle of Rivnuts, their construction and applications. (216)

Welding. Graver Tank & Mfg. Co., Inc., 16 pp, ill. Describes plant's facilities for large weldments and suggests applications. (217)

Wing Nuts. Gries Reproducer Corp. Data on zinc alloy wing nuts, said to be strong, rust-proof, low cost, available in all commercial finishes and thread sizes. (218)

Brazing. Handy & Harman, ill, No. 54. "Brazing News" describes applications and developments of Easy-Flo and Sil-Fos low temperature silver brazing alloys. (219)

Fasteners. H. M. Harper Co., 8 pp, ill, Vol. 19, No. 2. Various case histories of the applications of Harper's fasteners, emphasizing corrosion-resistant bolts. (220)

Spot Welding Aluminum Alloys. P. R. Mallory & Co., Inc., 36 pp, ill. Detailed description of spot welding for aluminum alloys, plus specifications and diagrams. (221)

Welding Machines. Sciaky Bros., Inc., 5 pp, ill. Description of multiple gun electrical resistance welding machines. (222)

Fastener Demonstrator. Set Screw & Mfg. Co. Cardboard demonstrator shows the way Zip-Grip set screws lock themselves into place. (223)

Copper-Aluminum Welding. Taylor Winfield Corp., 4 pp, ill. Description of the technique of resistant flash-butt welding for joining copper to aluminum. (224)

Blind Rivets. Townsend Co., 12 pp, ill. Types of Cherry Blind rivets and examples of their use in fabrication (225)

Brazing Alloys. United Wire & Supply Co., 3 pp, ill. Wire brazing aluminum for low temperature brazing of various metals and alloys. (226)

Forming • Casting • Molding Machining

Deep Drawn Shapes. Cincinnati Milling Machine Co., 19 pp, ill. Hydroform process from 12 in. to 32 in. for short runs in development and quality production purposes. (227)

Tablet Presses. Kux Machine Co., 4 pp, ill. Tableting presses for production of powdered metal parts, ceramic parts, explosives, etc. (228)

Cold Extrusion. Mullins Mfg. Corp., Kold-flo Div., 16 pp, ill. How low carbon steel parts are cold extruded and fabricated in one piece without machining. (229)

Tube Mills. The Yoder Co., 65 pp, ill. Pros and cons of operating a tube mill, plus detailed information on the process. Also technical data on standard and other equipment. (230)

Inspection • Testing • Control

Precision Optical Instrument. American Cystoscope Makers Inc. Features and typical uses of ACMI borescopes for precision inspection. (231)

Spectrograph. Bausch & Lomb Optical Co., 20 pp. Describes large Littrow spectrograph, medium quartz spectrograph and densitometer for spectrum analysis. (232)

Radiography. General Electric Co., X-Ray Dept. A new house organ, "Radiation Digest," devoted to industrial x-ray applications and commercial irradiation techniques. Contains news of the field and feature articles. Published quarterly. (233)

Temperature Controls. Claude S. Gordon Co., 4 pp, ill. Brief description and advantages of straight line, fully automatic temperature control. (234)

Torsion Tester. Riehle Testing Machines Div., American Machine & Metals, Inc., 8 pp, ill. Machines for twist-testing components, assemblies, sample stock and wire. (235)

Tensile Testing Machines. Scott Testers, Inc., 6 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strength of materials such as rubber, paper, wire and threads. (236)

Impact Tester. U. S. Testing Co., Inc., 2 pp, ill. Gives history, description and use of the SPI low temperature impact tester. (237)

Hardness Testers. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. Engineering data, uses and design features of Rockwell hardness testers. (238)

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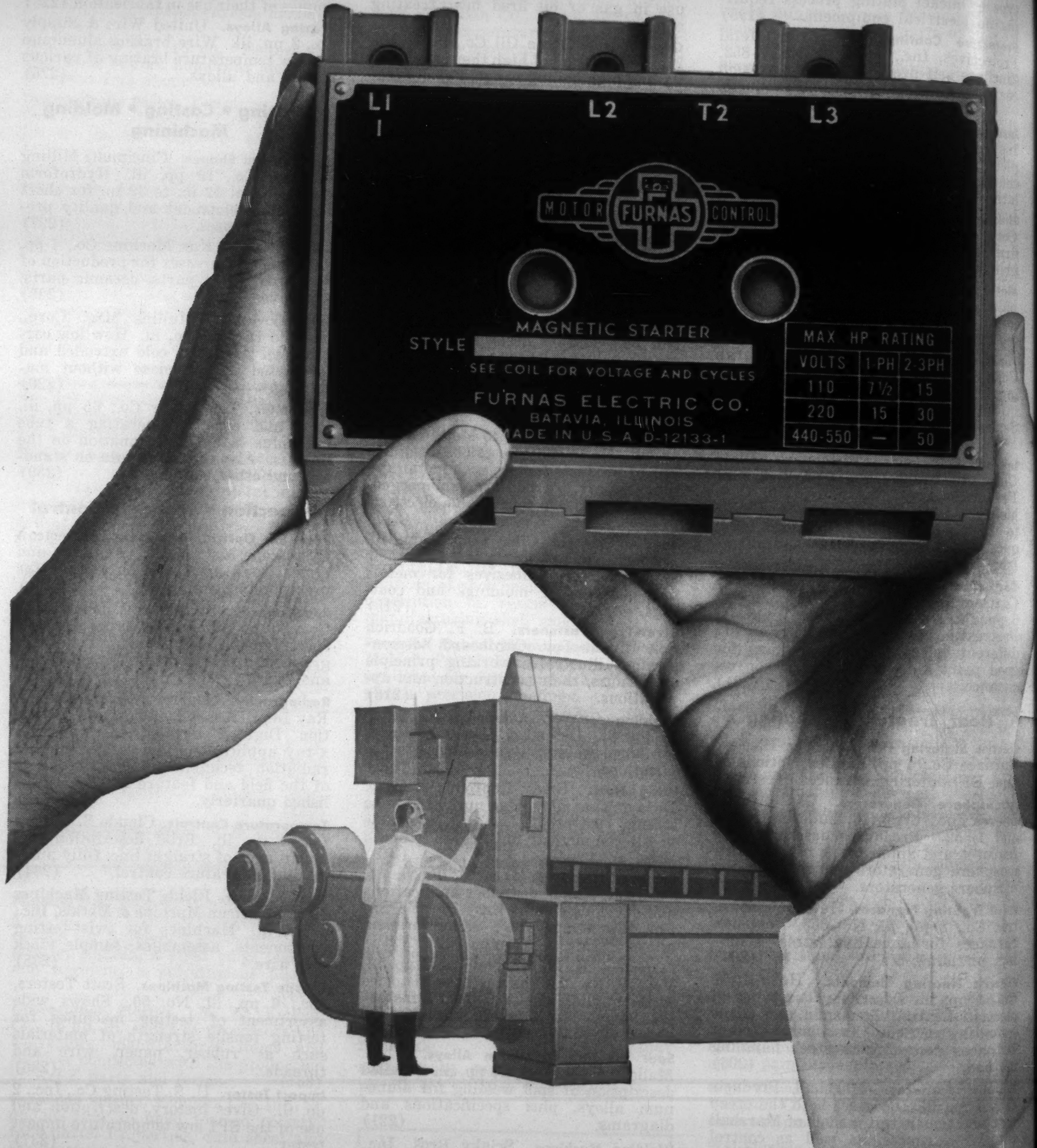
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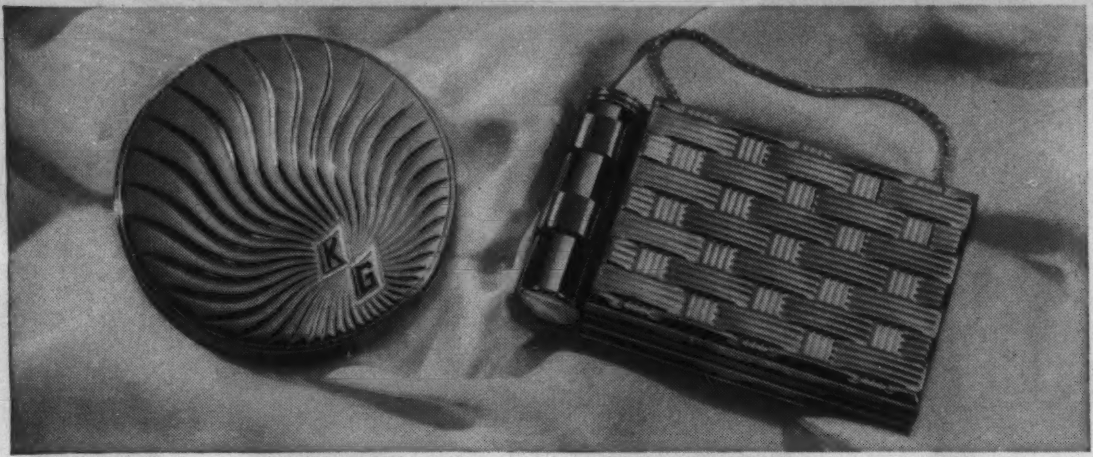
BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co.

Reporting new developments in copper-base alloys and metalworking methods.



Bridgeport High I. Q. Brass gives rich gold color, high gloss finish to stylish vanity and lipstick cases. (Courtesy, Zell Products Corp., Norwalk, Conn.)

Beauty in Brass: A Story of the 4th Dimension

"Rich as gold," describes the deep warm color of Bridgeport 87 Brass. And, "polished as a mirror," describes the lustrous finish Zell Products Corp., Norwalk, Conn., gives to its line of vanity and lipstick cases. The success of this story belongs to the High I. Q. (Inner Quality) of Bridgeport brass strip, and the 4th Dimension, its optimum grain size.

The cases are made primarily by blanking, stamping and cupping thin strips of brass (Alloy 87); 87% copper, 13% zinc. Therefore, a certain amount of ductility is essential in the metal. The mirror-smooth polish is brought out by buffing, which calls for a fine grain size. The combination of these two qualities is a finely-balanced compromise to bring both properties to ideal working requirements.

Bridgeport supplies this exceptionally smooth metal, tailored to the customer's requirements—⅛th hard and light anneal temper, with .015 mm grain size. Metal of this temper provides an extremely smooth surface after forming which may be buffed to a high gloss with a minimum of labor and time. It has an ideal combination of ductility and ability to take a high polish for a great many profitable applications.

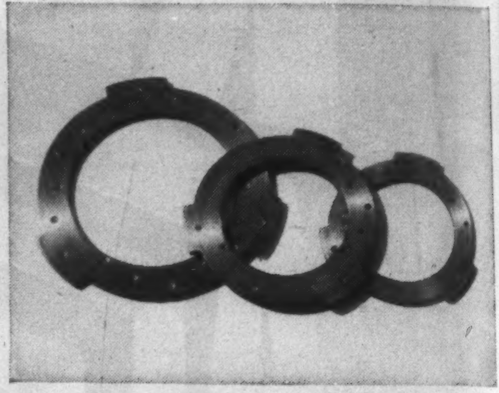
Many other combinations are also available, each suited to a particular range of forming and buffing requirements. So ask your Bridgeport Technical Service representative to assist in your metal selection. Make sure of the 4th Dimension—the right grain size to meet both product needs and production methods, for no one fine-grain brass does all jobs well.

Bridgeport Phosphor Bronze Makes Tough, Long-Wearing Clutch Plates

Since 1929, the Rockford Clutch Division of Borg-Warner Corp., Rockford, Ill., has used Bridgeport Phosphor Bronze Grade A (Alloy 36) for clutch outer discs in their Pullmore Multiple-Disc Clutches. They have used this alloy consistently because of its outstanding strength and superior resistance to wear under severe operating conditions, another example of properties assured by the High I. Q. (Inner Quality) of Bridgeport alloys.

The alloy is supplied by Bridgeport in strip form, rolled to an extra spring temper of 9 B&S numbers hard, and having correct surface finish to meet specifications. Automatic machines stamp blank discs, 1¾ in. to 10⅞ in. in diameter, from three thicknesses of strip; .062 in., .092 in. and .125 in. Each is then pierced with a large hole for the clutch shaft and with a series of small holes around the working periphery of the clutch disc. They are then flattened, heat treated to 500°F. The small holes are impregnated with graphite to complete the part.

The clutches in which these discs perform are used on main drives, auxiliary controls, and power take-off mechanism to obtain forward and reverse movements, or high and low speeds. They serve as both clutch and brake, and therefore must be rugged.



Clutch discs of Bridgeport High I. Q. Phosphor Bronze have high strength and wear resistance in heavy-duty service. (Courtesy Rockford Clutch Division, Borg-Warner Corp.)

Composed of approximately 95% copper and 5% tin, Bridgeport Phosphor Bronze Grade A (Alloy 36) has high resistance to fatigue and wear from rubbing against other materials, excellent spring properties under repeated flexing, and greater resistance to corrosive attack than most brasses and copper.

This alloy is also recommended for use in metal bellows for temperature and pressure control instruments, clutch discs, bridge bearing plates, screens and beater bars in many of the process industries; snap switches, spring contacts and other parts for electrical and electronic equipment.

For even more severe service, Bridgeport Phosphor Bronze Grade C (Alloy 35), composed of 92% copper and 8% tin, would be the preferred alloy. High I. Q. metals are produced with Inner Qualities to meet the most rigorous specifications of the industry. (3138)

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One point of view

The Materials Show— Its future

Prior to the opening of the first Materials Show two years ago, we became so enthusiastic about the project that many people assumed that we were sponsors of the affair. We can't claim any credit for the idea. That all goes to Clapp & Poliak, Inc., owners and sponsors of the show. Our enthusiasm was undimmed prior to the second show and continued unabated for the third show which had been scheduled for late this month. Our enthusiasm and support were due to the fact the show's objectives so closely paralleled our own.

However, circumstances have caused the third Materials Show to be deferred until it can reappear as part of a larger show. We, of course, had no part in this decision. Clapp & Poliak cannot be blamed for reexamining the original concept of the show when the very people it was designed to benefit failed to support it. Materials and parts producers who should have backed the project adopted a wait and see attitude about the show. The trouble is they waited too long. Those exhibitors who participated in the first two shows felt well repaid for their time, effort and money. So did the people visiting the exhibits and conferences. Quality was high but quantity was low.

Now, then, what is to become of the Materials Show?

According to the sponsors, the framework of the Materials Show will be absorbed into a more inclusive Design Engineering Show slated to make its debut in 1956.

We definitely feel that there is a need for one show which will bring together all engineering materials under one roof. If this can only be done as a part of a larger show, then we will give our blessings to it. Our editorial interest is concentrated on the engineering materials, parts and finishes used in product design and manufacture. Thus, only that portion of the show which falls within our editorial sphere will excite our strong interest. We exclude from our editorial coverage the problems of mechanical design and styling.

The attitude we are taking is understandable when viewed in relationship to other trade shows in which we participate. We are not interested in how metals or plastics are made, but we support the Metal Show and the Plastics Show insofar as they are concerned with the *selection* and *application* of metals or plastics as engineering materials.

All this is by way of explaining that we still plan to cooperate with Clapp & Poliak in support of any new show which gives major attention to all of the engineering materials. We are only sorry that not enough other supporters could be found to make an exclusive Materials Show a major success on its own.

T. C. Du Mond

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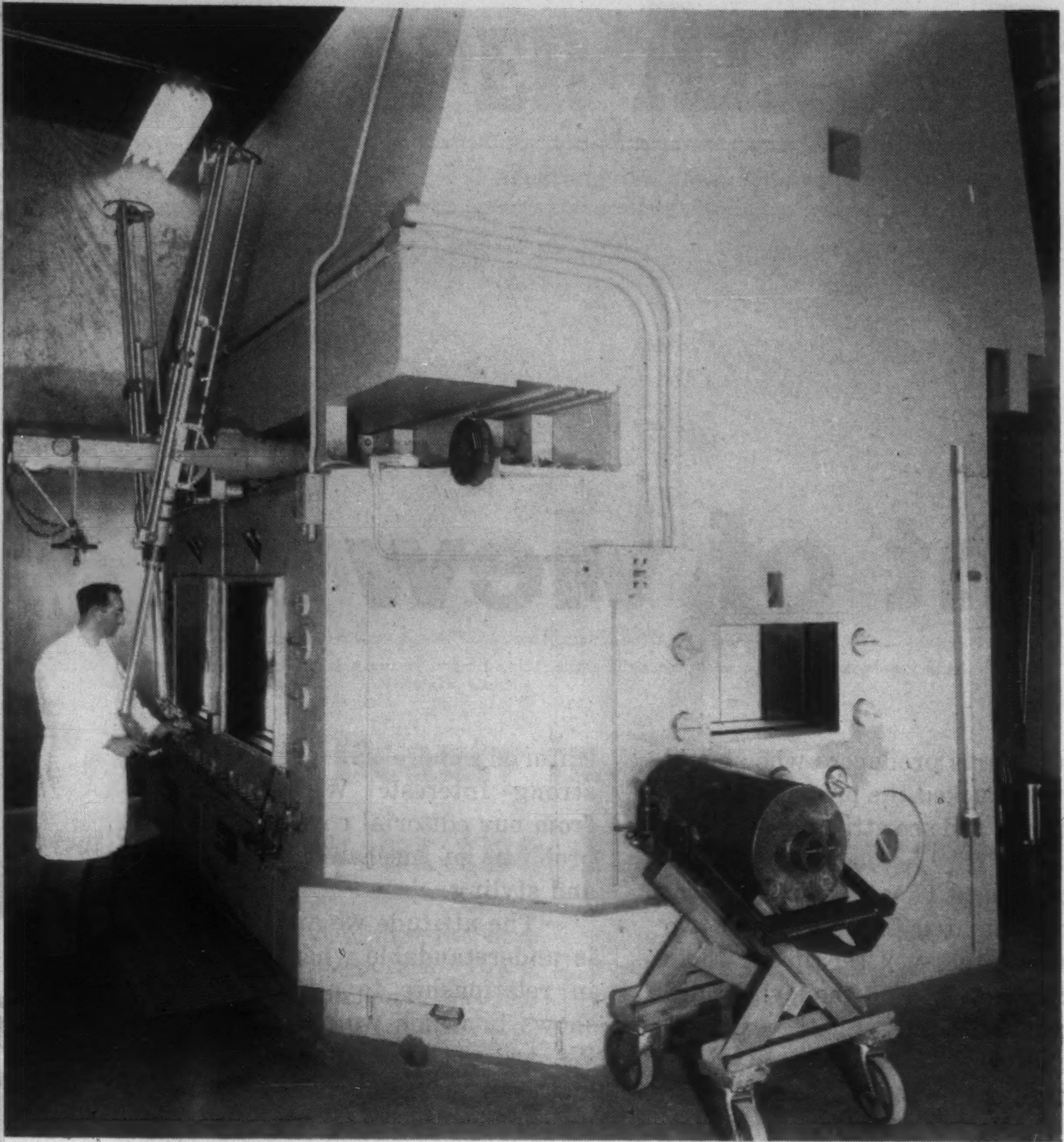


***Operating mechanisms** require the use of suitable materials for gears, bearings, control rods, instruments and similar parts.*

Engineering Materials in Nuclear-Fueled Power Plants

An up-to-date account on

- *What properties are required in materials for nuclear-power equipment.*
- *What materials are being used for structural members, fuel canning, reactor shielding, controls and coolants.*

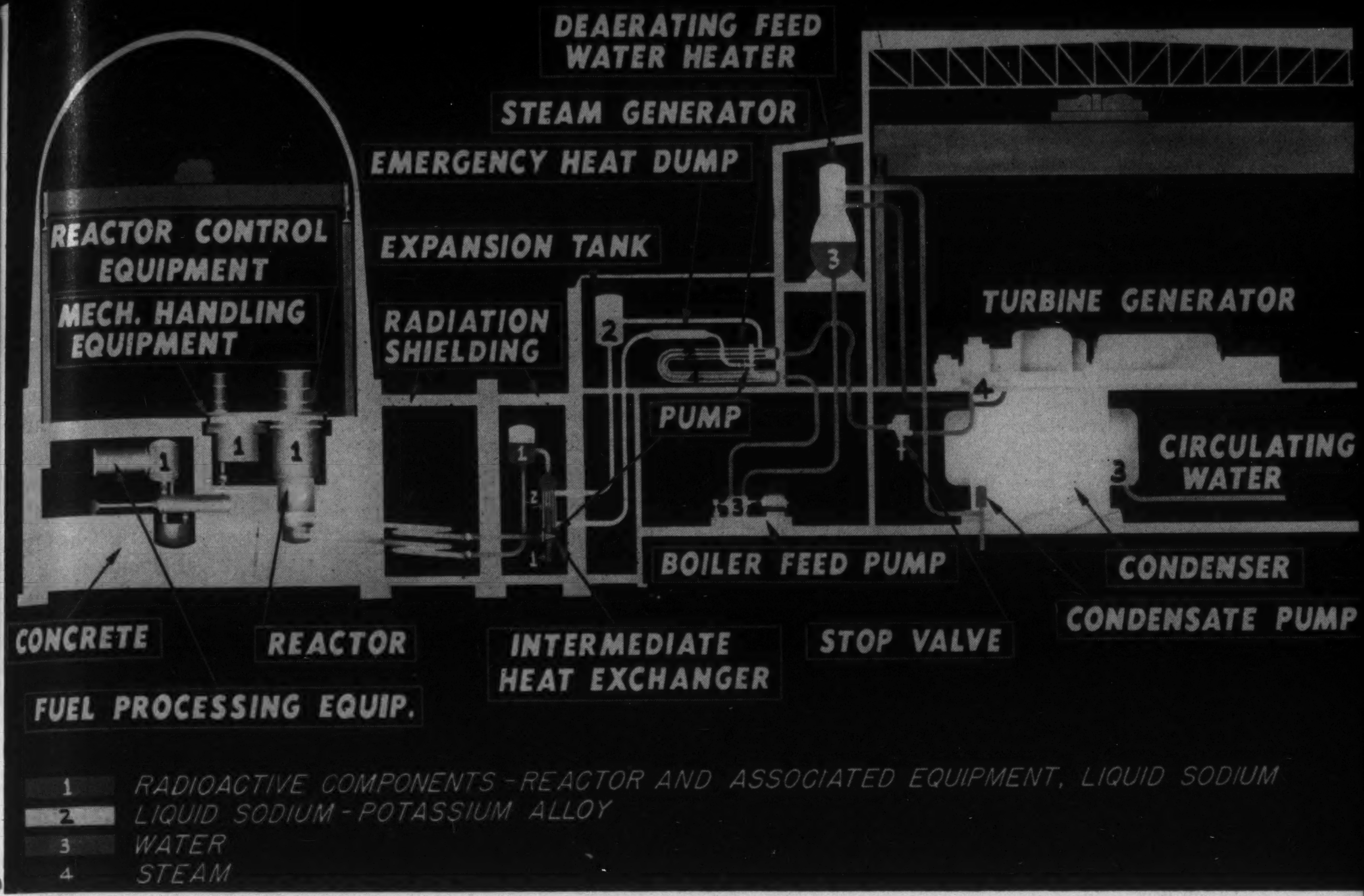
by D. O. Leeser, *Nuclear Power Development Dept., the Detroit Edison Co.*

■ The development of nuclear reactors to produce heat for electric-power generation is a problem which confronts the nuclear engineer. Advanced reactors are being designed to operate at highest-possible heat fluxes to insure economy at maximum-power output. Material selection, in turn, is compounded by operating conditions that vary over a tremendous range of temperature, pressure and electric power.

The requirements for optimum power demand that reactors operate at high neutron fluxes (many fissions per second). Therefore, in addition to cost and availability, the neutron properties and corrosion resistance are the most important criteria for the selection of materials. Neutron-property evaluation includes absorption and scattering of neutrons, resistance to radiation damage and dimensional changes during irradiation, and radioactivity build-up in the material itself.

Reactors fueled with enriched uranium, or U-235, have been constructed and operated. However, converting the concentrated heat potential of this fuel into superheated steam, to produce power, requires a complex plant. Included in the requirements for such a plant are primary and secondary cooling systems, specially designed heat exchangers, critical and accurate control mechanisms, and built-in remote-handling facilities. Fortunately, there has been no dearth of designs of nuclear reactors technically capable of producing electrical power. The problem has become one of balancing economic aspects with technical and design specifications.

The reactor engineer designs equipment based on assigned temperature reactivity and pressure data. These are converted to stresses by mathematical formulae and whatever strength-of-materials data are available. Since no material is foolproof under all conditions, no matter how high in alloy content or any other attribute, a knowledge of its limi-


DEAERATING FEED WATER HEATER
STEAM GENERATOR
EMERGENCY HEAT DUMP
REACTOR CONTROL EQUIPMENT
EXPANSION TANK
MECH. HANDLING EQUIPMENT
RADIATION SHIELDING
TURBINE GENERATOR
PUMP
CIRCULATING WATER
BOILER FEED PUMP
CONDENSER
CONDENSATE PUMP
CONCRETE
REACTOR
INTERMEDIATE HEAT EXCHANGER
STOP VALVE
FUEL PROCESSING EQUIP.
1 RADIOACTIVE COMPONENTS - REACTOR AND ASSOCIATED EQUIPMENT, LIQUID SODIUM
2 LIQUID SODIUM - POTASSIUM ALLOY
3 WATER
4 STEAM

Possible arrangement *of a steam power plant utilizing heat energy from a nuclear reactor.*

tations is necessary in planning and designing nuclear-power equipment.

Consider the different materials for various functions in a nuclear reactor. Included are the fuel and fertile materials, moderators and reflectors, reactor structural members, fuel canning or cladding, reactor shielding and controls, and effective coolants.

The successful solution of each technical problem necessitates the selection of materials with adequate mechanical, physical, and nuclear properties. Materials must be capable of being formed and/or joined and the strength at operating temperatures must be within design limits. Thermal conductivities and heat-transfer coefficients must be high. Expansion coefficients of materials should be compatible. Thermal and hydraulic properties of coolant fluids must be satisfactory and corrosion rates must be within acceptable limits.

These and other standards must be met with materials of suitable nuclear characteristics. Quantities of materials in the reactor core must be carefully controlled because the amount of moderator and coolant and the amounts and design of fuel materials and structural parts are important factors in the neutron and heat balance in the reactor. In the nuclear reactor, the materials in the chain-reacting system must not parasitically capture an excessive number of neutrons. A proportion of the neutrons produced by the fission of uranium atoms must be available to continue the fissioning process. Many materials that do not contribute to the fission process absorb neutrons and emit gamma rays that do not enter into the production of neutrons.

Nuclear fuels

The fuel is contained in a removable section of the reactor called the core. Here the major portion of the total reactor heat is generated. The quantity of fissionable material in the core must be sufficient to continuously sustain the chain reaction, provide an excess amount to compensate for fuel burn-up, and supply excess reactivity to permit start-up at any time.

Possible fuel materials include uranium, thorium, and plutonium. U-235 is the only naturally-occurring fissionable material or fuel, and less than 1% U-235 occurs in natural uranium. U-238 and Th-232, which are source or fertile materials, may be converted into U-239 and Th-233, and then into the fissionable materials Pu-239 and U-233. The process involves absorption of neutrons generated during the chain reaction, and then normal radioactive decay to the desired product.

Natural uranium is a dense material, 1½ times heavier than lead. It has fairly high thermal conductivity (approximately 15 Btu/hr/sq ft/ft/°F) and can be used in metallic form. The physical form used in specific circumstances depends upon the size of the unit, the properties required of the fuel, the convenience of handling, and the shape desired. The shape of the fuel element is selected to minimize physical changes that occur on irradiation. Anisotropy, or preferred orienta-

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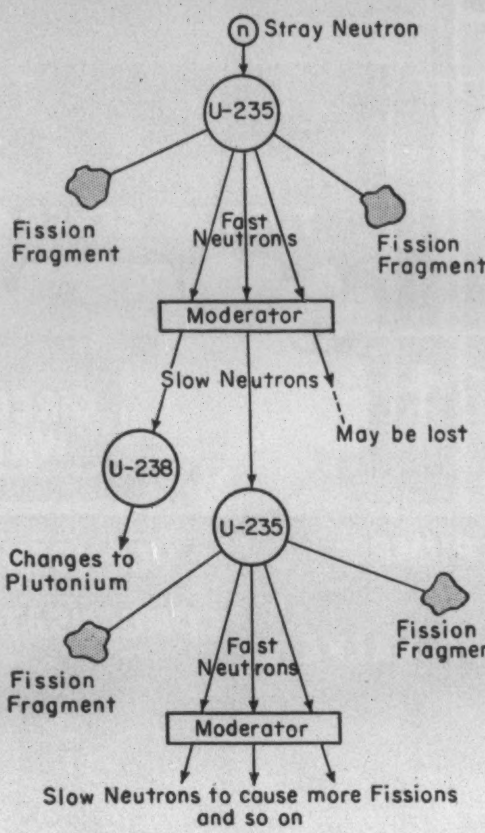


Schematic diagram of a fission chain reaction using a moderator to slow neutrons to speeds more likely to cause fission.

tion of the internal structure imposed during fuel fabrication, may lead to plastic strains on heating and cooling.

Engineering design of fuel elements for a particular reactor must strive toward minimum uranium and enrichment levels. Criteria for minimum amounts include self-maintenance of the chain-reaction and reasonably-uniform heat generation. Since no "ideal" fuel element material has been found, each design should represent the best possible compromise among nuclear, mechanical, and physical properties. To produce such an element, the design engineer must be well versed in reactor physics, stress analysis, metallurgy, heat transfer, fluid mechanics, and shop practices.

Moderator and reflector

A moderator is a low atomic-weight material placed in a thermal reactor to slow down the neutrons to thermal energies. The use of slow neutrons enhances a chain reaction in natural uranium since fissionable material absorbs slow neutrons more readily than fast neutrons. When no moderator is used, the chain reaction is maintained by fast-neutron-induced fissions and the reactor is called a fast reactor. The reflector surrounding the fuel section prevents escape of much-needed neutrons by "bouncing back" a large fraction of the neutrons to the core.

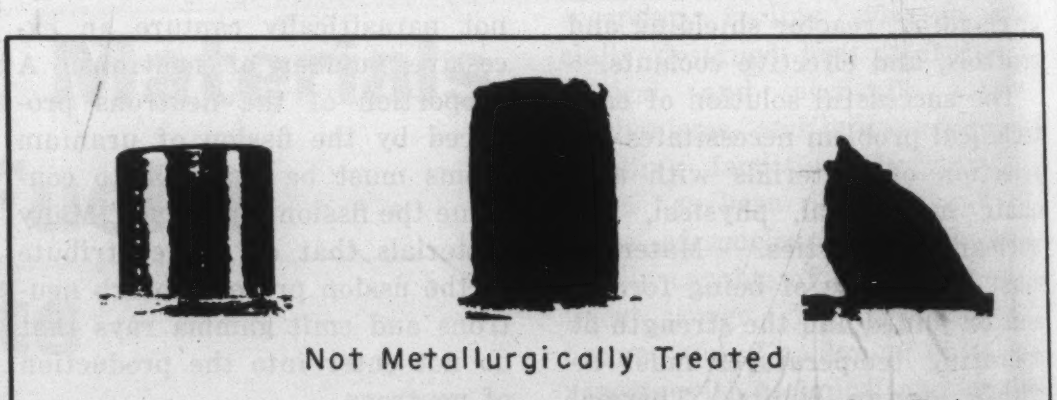
Moderator and reflector materials must be particularly free of thermal-neutron-absorbing elements such as boron, lithium, cadmium and cobalt. The best moderating and reflecting elements are hydrogen and deuterium, followed by beryllium and carbon. Ordinary water, containing hydrogen, is cheap and readily available while heavy water, which contains deuterium, is superior but costly and difficult to manufacture. Either type of water must be pressurized to overcome the limitations imposed by its low boiling temperature.

Although costly, beryllium and beryllium oxide have excellent corrosion resistance to pure water. Metallic beryllium is usually brittle up to 400 F but above this temperature it is ductile and can be worked. This metal is comparatively resistant to oxidation up to 1100 F; at higher temperatures, and when molten, it oxidizes rapidly. Beryllium can also be used in a reactor as the oxide, known as beryllia. This is a ceramic material with a melting point of approximately 4450 F. Care must be exercised in using beryllium because the metal and its compound are poisonous to some people when inhaled or ingested even in small amounts.

Graphite is a form of carbon which is now being produced with extreme purity on a very large scale. It can withstand elevated temperatures, has good resistance to thermal shock and has relatively low coefficient of thermal expansion. The room-temperature strength is essentially maintained at high temperatures. Thermal conductivity values are high, coming within the ranges expected for brasses.

Control and shielding

The fuel supply for a reactor is completely contained within the reactor core. Since solid fissionable fuel cannot be fed into a reactor and consumed as supplied, the necessary quantity must be in place initially. There is, then, a concentration of a supercritical mass of fissionable material within a small volume that requires the use of high-neutron-absorbing materials to guarantee safe and controlled operation.


Not Metallurgically Treated
Before
After Certain Exposure in Reactor
After Twice as Much Exposure
Metallurgically Treated

Physical changes resulting from radiation in a reactor.

TABLE 1—SLOW NEUTRON ABSORPTION BY STRUCTURAL MATERIALS

Material	Relative Neutron Absorption per cu. cm x 10^3	Relative Neutron Absorption for Pipes of Equal Strength, 68 F	Melting Point, F
Magnesium	3.5	10	1200
Aluminum	13	102	1230
Stainless Steel	226	234	2730
Zirconium	12.6	16	3330

TABLE 2—SLOW NEUTRON ABSORPTION CROSS SECTIONS

Low		Intermediate		High	
Element	Cross Section, barns	Element	Cross Section, barns	Element	Cross Section, barns
Oxygen	0.0016	Zinc	1.0	Manganese	12
Carbon	0.0045	Columbium	1.2	Tungsten	18
Beryllium	0.009	Barium	1.2	Tantalum	21
Fluorine	0.01	Strontium	1.3	Chlorine	32
Bismuth	0.015	Nitrogen	1.7	Cobalt	35
Magnesium	0.07	Potassium	2.0	Silver	60
Silicon	0.1	Germanium	2.3	Lithium	67
Phosphorus	0.15	Iron	2.4	Gold	95
Zirconium	0.18	Molybdenum	2.4	Hafnium	100
Lead	0.18	Gallium	2.8	Mercury	340
Aluminum	0.22	Chromium	2.9	Iridium	470
Hydrogen	0.32	Thallium	3.3	Boron	715
Calcium	0.42	Copper	3.6	Cadmium	3000
Sodium	0.48	Nickel	4.5	Samarium	8000
Sulfur	0.49	Tellurium	4.5	Gadolinium	36000
Tin	0.6	Vanadium	4.8		
		Antimony	5.3		
		Titanium	5.8		

Safe and stable reactivity control of the power level is maintained by absorbing, in control rods, a portion of the neutrons being produced. The rods must have adequate structural strength, resistance to radiation damage, high thermal conductivity, and a high neutron-capture probability. For thermal reactors, materials with high neutron cross sections, such as cadmium and boron, are used. In a fast reactor, all materials have relatively low cross sections and the problem is one of design as well as material selection.

The shielding section is provided to reduce hazardous neutron and gamma radiations to a safe external level. It is usually divided into two parts with separate functions. One is the thermal shield to slow down the fast neutrons and to absorb, partially at least, the thermal neutrons and gamma rays. The other is the biological shield which reduces the escaped or reproduced neutrons and gamma rays to tolerable levels for humans.

The choice of shielding materials is governed by three criteria: 1) gamma-attenuating, neutron-moderating and neutron-absorbing properties; 2) weight that can be allotted to the structure; and 3) cost. Lead, tungsten, tantalum or iron combined in some form with moderating materials such as boron, water or concrete make good radiation shields.

Auxiliary system materials

Successful operation of a nuclear reactor depends on the proper choice of materials used in operating mechanisms and plant structure, cladding or canning of solid fuel, and sensing and instrumentation units. A reactor with only chain-reacting fuel cannot be successfully controlled. Therefore, operating mechanisms and auxiliary structures are included in the design.

Operating mechanisms, usually actuated by controlled servo devices, require the use of suitable materials for gears, bearings, control rods, springs, instruments, electrical connectors, etc. Auxiliary structures and plant include materials for pressure vessels and closures, valves, piping, pumps, welded components, and other related equipment.

Some structural and cladding materials which have been or could be used in reactors are given in Table 1. Although mechanical and physical properties of contemplated structural materials are important, their position and effect on the reactor must be considered also.

Relative neutron absorption is given in the table and supplemented with the relative absorption for pipes of equal strength and identical internal diameters. Although magnesium and aluminum are more suitable than stainless steel they are ruled out for a power reactor because of corrosion difficulties and low melting points. The comparison points out the superiority of zirconium.

Uranium fuel elements are protected by a coating or cladding because bare uranium is chemically active. It is corroded by air

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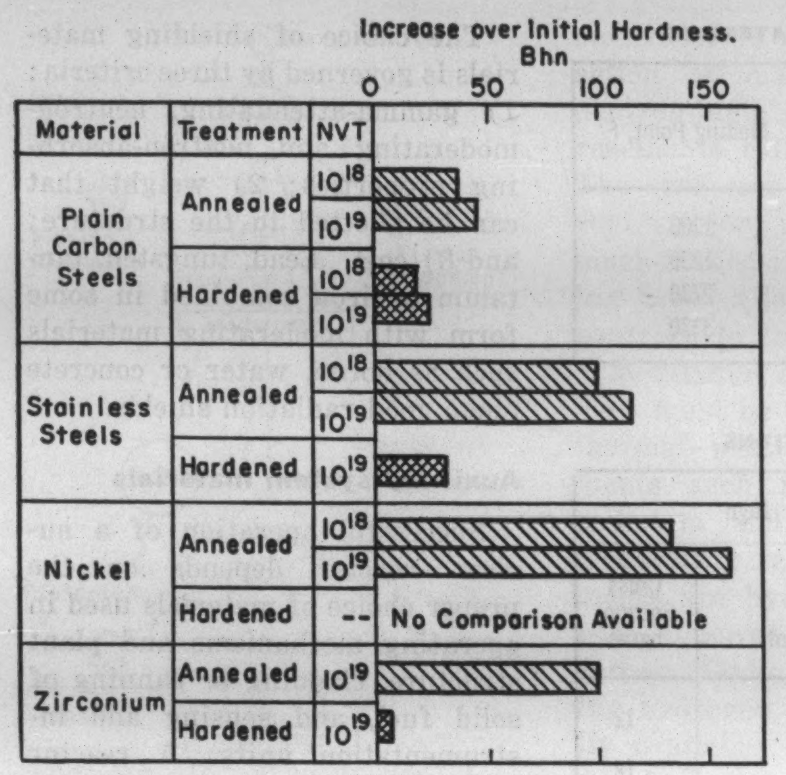
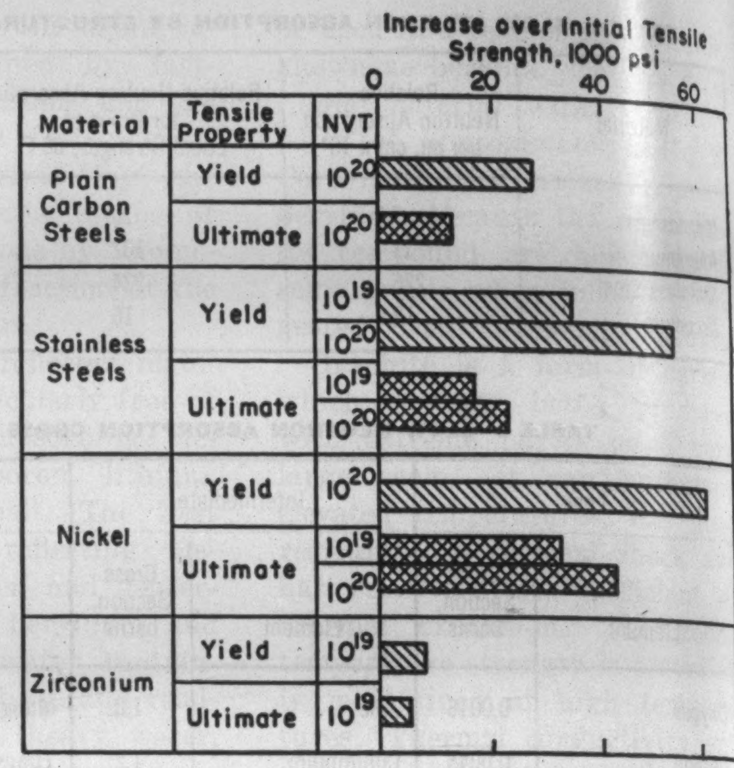


Effect of irradiation on hardness of some metals.



Effect of irradiation on tensile strength of some metals.

and water at room temperatures. Cladding material requirements include not only reasonable cost and strength but also low neutron cross sections and high thermal conductivity.

Some idea of the relative cross sections of potentially useful materials for reactors can be gained from Table 2. The slow neutron absorption cross sections are given for the common elements, and from these values, the cross sections of alloys can be calculated.

It should be realized that the operation of a reactor imposes unusual conditions on structural materials. One such condition is the effect of irradiation produced when a charged particle of high velocity collides with the nuclei of atoms in its path. If the energy lost in a collision is large, an atom in the bombarded material is ejected from its lattice position causing a displacement.

Mechanical and physical properties of materials may be altered by cold work and are also known to be affected by irradiation. In each case, the effect has been attributed, in part, to the rearrangement of atoms within crystals and subsequent formation of dislocations in the atomic lattice. The effects of irradiation dosage on the hardness and tensile properties of structural materials used in reactors are shown in graphs.

The presence of a small percentage of random disturbances may result in a major change in properties, the changes being proportional to the fraction of displaced atoms. Correlation studies have shown that the effects of irradiation on metals are somewhat analogous to cold work with these important exceptions: 1) the mode of damage production is different, 2) the magnitude of irradiation hardening is not so large as the magnitude of cold-work hardening, 3) the radiation effect is applied on a localized and microscopic scale, and 4) the radiation effects are non-directional.

Problems also arise in the selection of materials to convey a signal sensitive enough, even under the effects of irradiation, to provide close instrument control over a wide range of temperatures. Unlike the conditions in conventional boiler rooms, reactor operating personnel are not in a position to see, hear or feel changes in reactor conditions. They operate in shielded control rooms and rely on sensing instruments for operational information.

There is little doubt that carbon steels, stainless steels, and nonferrous alloys of zirconium, cobalt and nickel will constitute a large portion of the auxiliary system materials in power reactors. Since steel imposes a severe penalty on the reactor because of its large parasitic capture of neutrons, it is used sparingly near the core. Therefore the AEC has expended much effort in obtaining and learning how to use zirconium. Unfortunately, zirconium ores contain hafnium and the natural zirconium-hafnium alloy is no improvement over steel with regard to neutron absorption. Therefore, hafnium-free zirconium is required for many reactor applications. In passing it may be noted that increasing the quantity of alloying element generally reduces thermal-conductivity levels to a point where the net gain in strength must be evaluated against the decrease in heat transfer.

Heat transfer materials

Special attention should be given to coolants and their influence on corrosion. The heatgenerating reactor core requires some medium to transfer heat from the core to other regions for use in converting water to steam. In a specific reactor, heat densities are high and heat removal must be efficient. At the same time, the transport of radioactivity through the power system must be kept at a minimum.

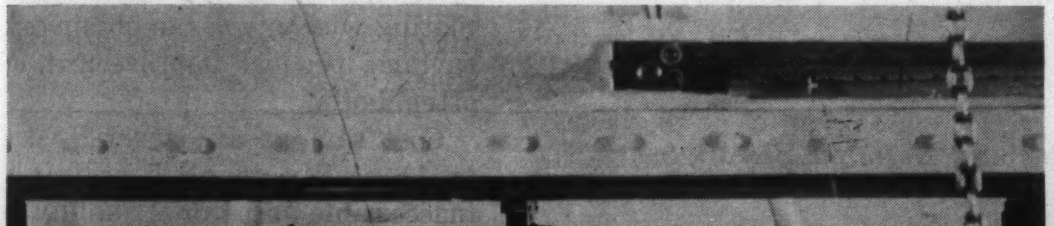
Sources of radioactivity in the cooling system are induced and direct. Induced activity results from neutron absorption by both coolant and corrosion products in the coolant stream. Fission products may enter the system directly as a result of fuel-element cladding failure. Little can be done to prevent induced activity in the coolant, since all materials exposed to radiation become radioactive to some extent. Transport of fission products can be minimized by effective fuel cladding and corrosion products by the use of relatively corrosion-resistant materials.

Although induced activity of the coolant is permissible if shielding is used, serious damage can result if the radioactive corrosion and fission products find their way into the coolant and are deposited on system components. Deposition of these corrosion and fission products interferes with the efficiency of the heat-source and heat-transfer surfaces and requires special precautions during maintenance.

For these reasons, the selection of a coolant must necessarily include the requirements of relatively low neutron-absorption characteristics and low corrosion rates on container materials. This last requirement is particularly important since corrosion rates usually increase with rising temperature.

Since it is difficult to predict where the transported radioactive products will deposit, all reactor coolant systems must be designed for minimum leakage. In special reactor types, where steam is taken directly from the reactor to the turbine, extra care must be taken to reduce the leakage from pipes and turbines. The need for low corrosion rates to insure integrity of piping that separates liquid metal and water in heat-transfer systems will be readily recognized since mixtures of these liquids are usually violent and may be explosive.

A comparison of the relative advantages and disadvantages of some coolants follows. Both light and heavy water have the advantages of high heat capacity and low neutron cross sections. However, they are actively corrosive and their high vapor pressures require heavy and expensive equipment. Sodium has the advantage of low pressures at high temperatures, high boiling point and high average thermal conductivity and is not particularly corrosive. Nevertheless, it is highly reactive with oxygen and water, freezes at about 200 F, and its induced-activity potential is high and relatively long lived.



Fissionable materials *must be machined and tested by remote control to protect the operator from the harmful radiation emitted.*

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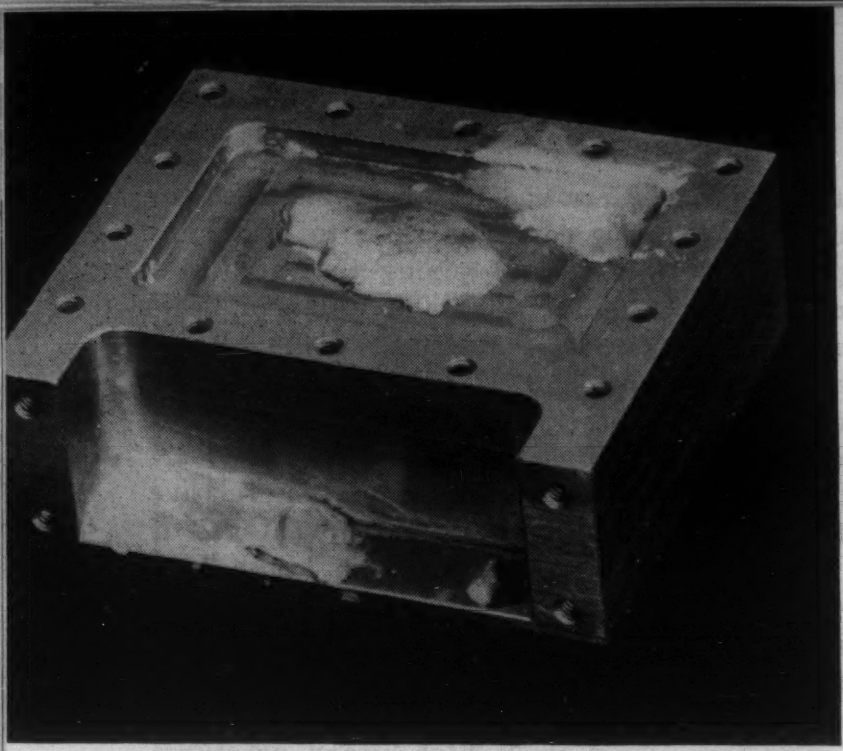
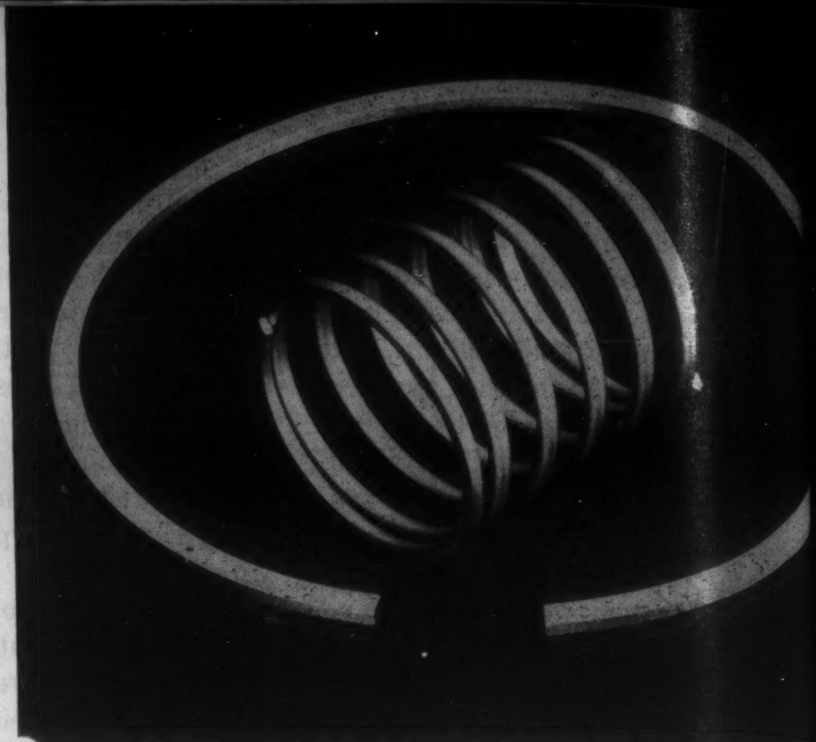


Aluminum *alloy (2024) transducer housing. Soft solder deposits illustrate solderability of nickel-plated aluminum.*



Steel *spring and piston ring. Note absence of plate build-up on sharp edges of piston ring.*

(All parts shown were plated by Chemplate Corp.)

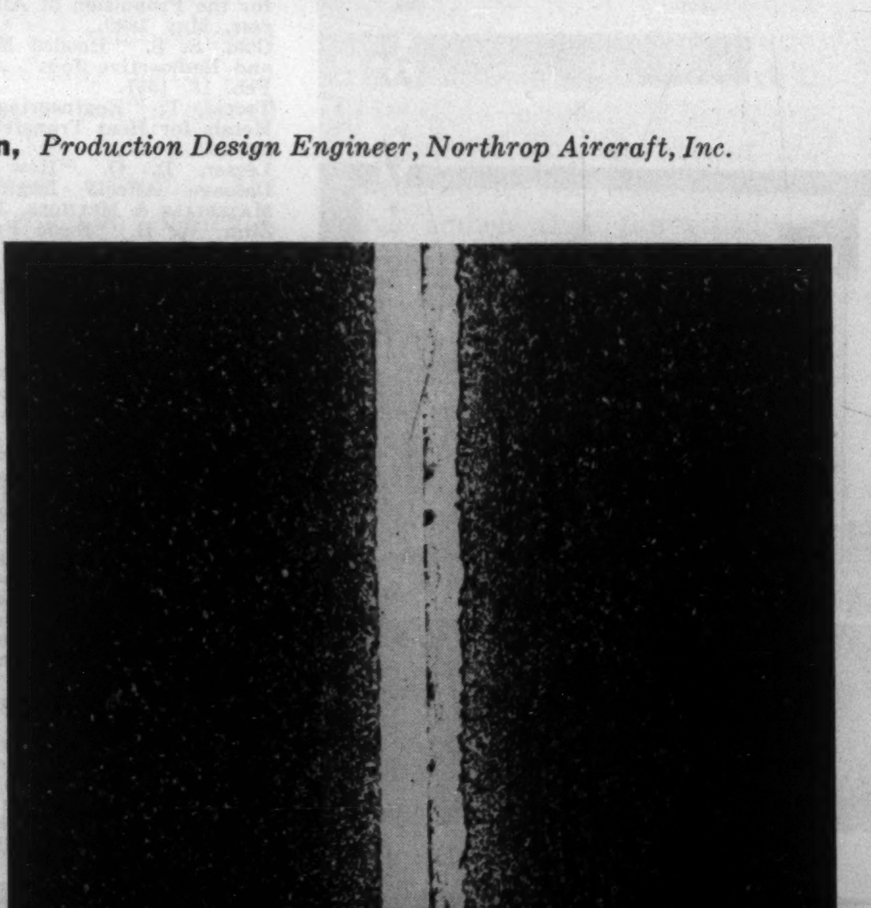
A new look at—

Electroless Nickel Plating

What It Can Do

Where It's Being Used

by J. L. Chinn, *Production Design Engineer, Northrop Aircraft, Inc.*



Photomicrograph *shows good and bad electroless nickel-plated specimens. Solid white areas are nickel (100x).*

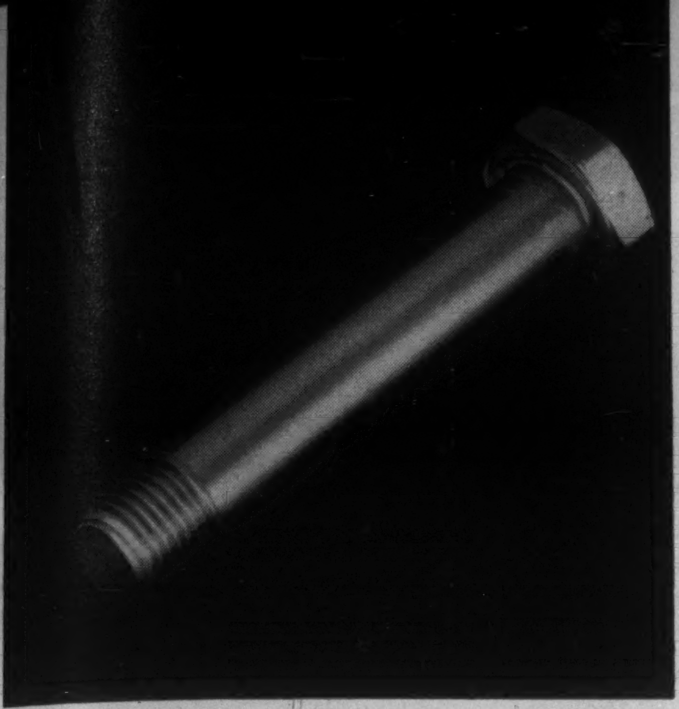
■ By specifying electroless nickel plating wisely, you can obtain cost savings, product improvement, or often both.

Cost savings are generally due to 1) ability to plate ordinarily inaccessible areas or 2) ability to build up and thereby salvage expensive overmachined parts.

Product improvement is generally obtained by 1) providing hard, strong surfaces on relatively soft lightweight materials or 2) providing close-tolerance corrosion- or wear-resistant surfaces on relatively inexpensive materials.

Chief advantages of electroless nickel plates compared to conventional electro-deposited plates are:

1. Uniform thickness. Plating occurs wherever the metal is in contact with the solution, and plate thickness depends only on temperature and time of immersion. There is no build-up at sharp edges, and there is no difficulty in plating deep recesses and internal surfaces. Close control over thickness eliminates need for "overplate and grind to tolerance" operations often required on precision parts.



Titanium *alloy (C-130AM) bolt.*

Copper *tube (center) plated on both interior and exterior surfaces. Solenoid core and aircraft actuator cylinder barrel are both of steel.*

2. Less hydrogen embrittlement. Chief limitation of electroless nickel plates compared with conventional electro-deposited nickel plates is higher unit cost, but this limitation does not apply to complex parts that cannot be satisfactorily electroplated at reasonable cost.

Following are the most important facts needed to determine whether electroless nickel plating may be suitable for any specific application.

Design

General design considerations include:

1. Base metals. All types of steels, copper and copper alloys can be plated. Aluminum alloys successfully plated are 2017, 2024, 2014 and 6061 wrought alloys; 356 casting alloy; and 13 die casting alloy. C-130AM titanium alloy has been plated. Brazed or silver-soldered surfaces of these materials can also be plated. Techniques for electroless nickel plating of other metals and alloys are being developed.

2. Thickness. Theoretically, there is no limit to the possible thickness of an electroless nickel plate. Plates of 0.013 in. have been deposited on a production basis in salvaging parts with overmachined holes. For most purposes, however, cost imposes economic limitations. Recommended plate thicknesses for various types of service are given in the accompanying table.

3. Tolerances. Extreme tolerances of ± 0.00005 in. can usually be held, but normal tolerances of ± 0.0001 in. are more economical.

4. Thread diameters. Although an electroless nickel deposit increases major and minor thread diameters by only twice the coating thickness, it increases pitch diameter by about four times the coating thickness.

Plate properties

Here is what you can expect from the plate itself:

Adhesion—Standard tests have shown that the adhesion is superior to that of conventional electrodeposited nickel; values exceeding 50,000 psi have been recorded. The superior adhesion of electroless nickel is a result of a combined chemical and mechanical

‣ *How the Process Works*

Electroless nickel plating is a method of depositing a nickel plate on ferrous and nonferrous metals without the use of electricity.

A complete description of the relatively new process was published by M&M just two years ago (May 1953, p. 96). Since then the process has been steadily improved and widely adopted, especially in the aircraft industry.

The electroless process deposits nickel by reducing a nickel salt to metallic nickel, sodium hypophosphite being the usual reducing agent. The part is immersed in the hot, buffered solution, although agitation may be desirable.

The "nickel" plate deposited by this process is actually only 93 to 97% nickel, the remainder being phosphorus. The nickel-phosphorus plate is quite hard and wear-resistant.

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RECOMMENDED PLATE THICKNESSES

Application	Plate Thickness, in.
Indoor Protection	0.0005
Mild Outdoor Protection	0.001
Severe Outdoor Service	0.0015 to 0.002
Abrasion Resistance	0.001 to 0.003

bond. Conventional electrodeposition provides an electrochemical bond, but, due to inferior throwing power, does not provide an equivalent mechanical bond or "dove-tailing" effect (see photomicrograph).

Appearance — "As-plated" appearance may be matte or bright, depending on the surface condition of the part before plating.

Corrosion resistance—Standard ASTM salt spray tests performed by Northrop have proved that electroless nickel plate, deposited as recommended by the Chemplate Corp., Los Angeles, exhibits excellent resistance to corrosion. For example, a steel specimen coated with an 0.0021-in. electroless nickel deposit withstood 288 hr in the salt spray cabinet without any sign of rust.

Hardness—Minimum plate hardness "as plated" is Rockwell C43. A minimum hardness of Rockwell C55 can be obtained by a post-plating thermal treatment. Some base materials, such as 2024 aluminum alloy, are adversely affected if exposed to plate-hardening temperatures.

Wear resistance—No general statement can be made since wear resistance is directly dependent upon anticipated service. Because of their phosphorus content, however, electroless nickel deposits possess an inherent lubricity; and in specific cases they have proved superior to other finishes in providing wear- and abrasion-resistance. For example, plated specimens of 0.040-in. 4130 steel were tested on a research model Taber Abraser using CS-17 calibrase wheels and an operating load of 1000 g. The average number of cycles required to wear through each 0.1 mil of nickel plate were as follows:

Electrolytic nickel	1300
Electroless nickel	2600

Cost

As in conventional electroplating, cost increases as plate thickness increases, as surface area increases or as tolerances get closer, and unit cost is higher for small quantities. Two additional cost factors should be noted:

1. Masking. It is usually cheaper to plate an entire part than to mask and selectively plate it.

2. Cleaning. Plating of inner surfaces of tubes or cylindrical parts raises problems in the removal of interior surface contaminations, such as weld scale and brazing flux, that are seldom encountered in electroplating.

Applications

Here are types of applications that have been successful:

Complex parts such as valves, regulators and bearings which could not be uniformly electroplated because of inadequate throwing power.

Miniature parts such as instrument parts, fine gears or threads where dimensional accuracy, uniform plate thickness and relatively close tolerances are required.

Internal areas of pipes, cylinders or tubes whose inner and outer surfaces could not be simultaneously finished by electroplating. Electroless nickel deposits have been successfully applied to solenoid interiors and to component parts of hermetically sealed units. Sealing of platable aluminum alloy units is readily accomplished by soft soldering after electroless nickel plating.

Less costly materials can sometimes be used. For example, low alloy steel parts coated with electroless nickel can be used instead of more expensive stainless steel parts in certain corrosive environments.

Weight reduction, of major concern to aircraft designers, can often be accomplished by specifying electroless nickel-plated aluminum parts instead of parts made from heavier metals. Such applications are restricted to those in which surface condition determines material choice.

Masking against nitriding, as in selective nitriding, can be accomplished by a 0.006-in. electroless nickel plate.

Electronic parts such as wave guides, contacts and printed circuits can be successfully coated with electroless nickel deposits. In addition to providing solderability and corrosion resistance, this finishing system is especially advantageous because it increases surface conductivity and, in printed circuits, maintains continuous contact without edge build-up. An electroless nickel-plated printed circuit actually becomes "one piece" because of the continuity of the nickel plate which covers all unmasked metallic parts.

Electrical parts where humidity causes damage. For example, miniature electric motors with electroless nickel-plated rotors can operate after prolonged humidity tests; un-plated rotors have corroded and "frozen" during similar tests.

Storage protection, especially for parts on which an electroless nickel plate is useful in service. A 0.0004-in. deposit has been specified for some corrodible steel parts destined for an estimated 6-yr storage period.

Salvage of parts by evenly building up over-sized holes, overmachined surfaces, threads, splines or serrations.

Special applications created by unusual requirements that occur in most development and prototype programs. For example, monel wire was required in a diameter that is not produced. The solution to this problem was to specify a smaller diameter wire which was subsequently electroless nickel-plated to the desired size.

Acknowledgment

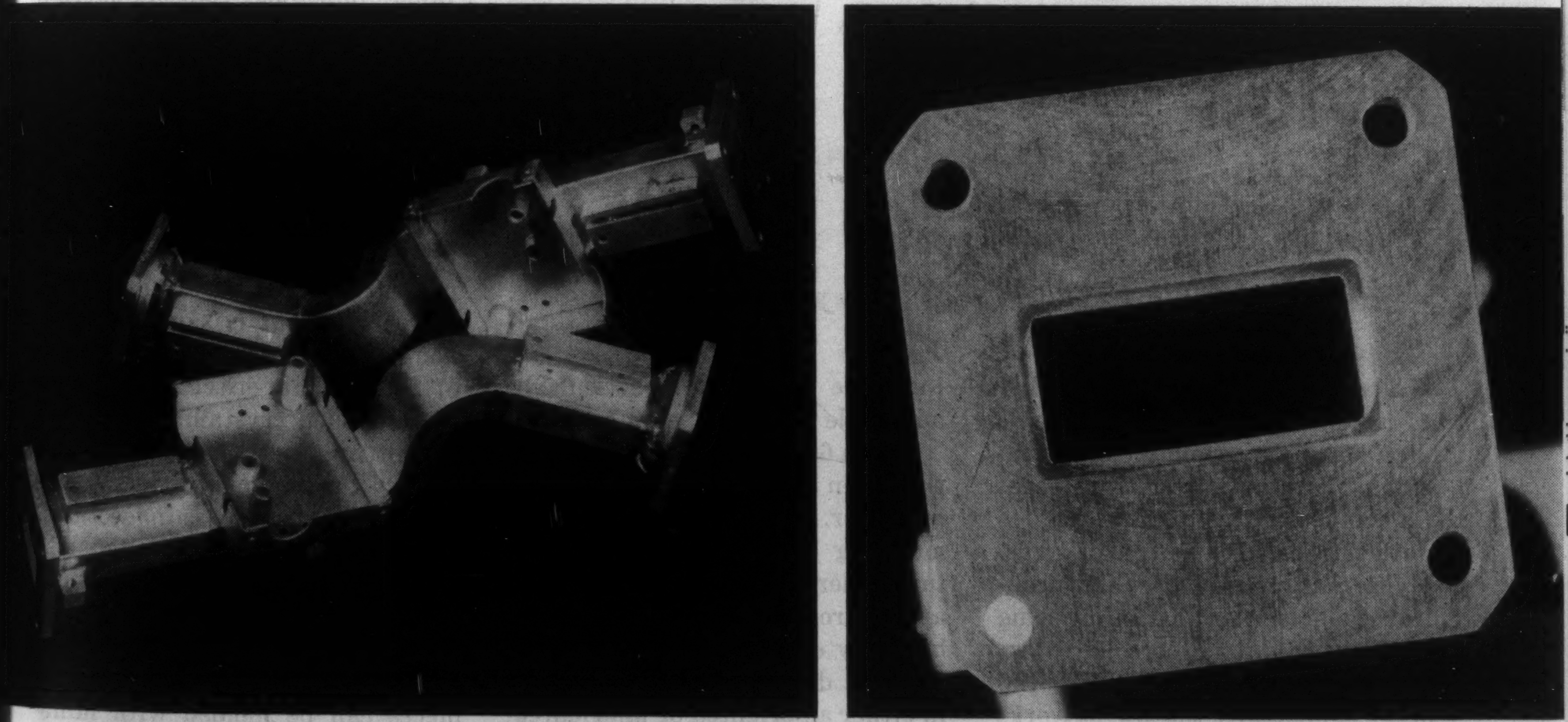
The author wishes to thank Bert J. Sherwood and Ed Zorn of the Chemplate Corp. for their technical advice and assistance; and Paul Fisher, H. E. Remillard and Tom Tanza of Northrop for their many helpful suggestions in the preparation of this article.

Materials at Work

New and old materials in unusual applications

Foamed Plastics Make Strong Core Materials

A new foamed phenolic resin offers a compressive strength of 37 psi for a 3-lb density and ranges up to 1100 psi for a 21-lb density. Called Corfoam 114, the material can be used for cores for metal-working dies, as insulating or sound-proofing material, as buoyancy cores for marine applications, orfor contour packing delicate products. It can be foamed in place or fabricated, and provides a relatively uniform cell structure, according to the manufacturers, Rezolin, Inc.



Precision Brazing Aluminum This aluminum wave guide contains about 10 parts which must be joined while holding tolerances of ±0.001 in. The assemblies are being dip-brazed by Technicraft Laboratories, Inc., and can be machined directly after brazing. Tolerances of ±0.001 must be held: 1) on dimensions of two slots on the bends of the wave guide; 2) on relationship of boss inside box in upper view to drilled hole in assembly shown in lower view; and 3) on relationship between two threaded pads and the hole shown in lower view.

The close-up end view shows brazed joint which has been faced off. Laboratory tests indicate this type of joint can withstand 72-hr test at 95 F and 95% relative humidity without corroding.

(Additional Materials at Work on p. 116)

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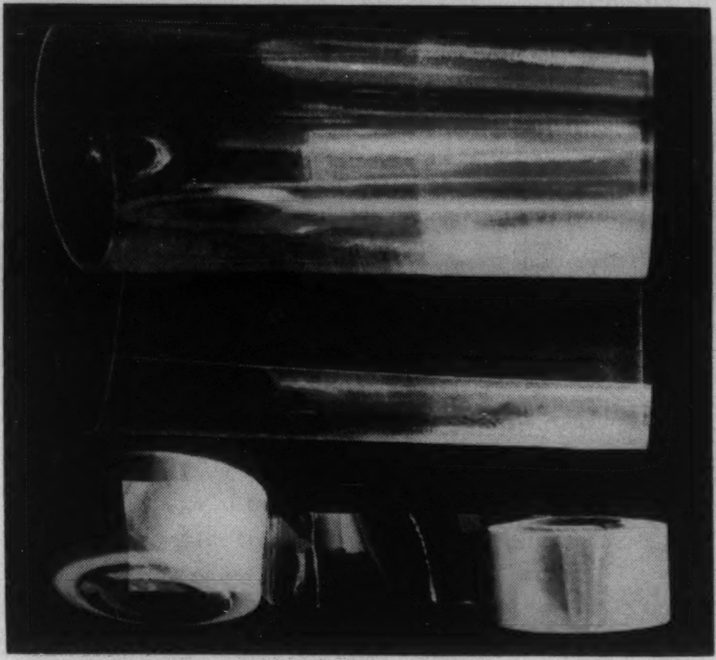
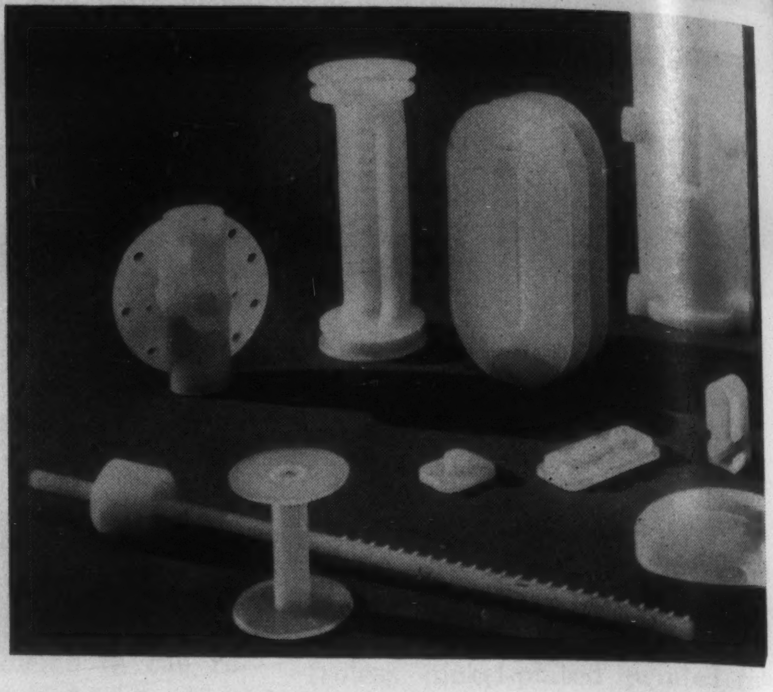


Extruded Film....



Molded Parts....

Easily formed with

New High Strength Nylon

A New Materials Preview

■ The high degree of moldability of a new type of nylon, known as type 6, allows commercial extrusion of transparent or translucent film and molding of larger parts with thicker sections free of voids. Nylon has offered peculiar problems to molders in that below some temperatures it is too solid to extrude or injection mold. On the other hand, above the lowest workable temperature it rapidly becomes so fluid that containment is a problem. Plaskon Nylon 8200, the new molding resin developed by Allied Chemical & Dye Corp., and marketed by Barrett Div., has a relatively high molten viscosity, minimizing problems of leakage from nozzles and joints, and making the material particularly adaptable to blow molding.

Nylon 6 is the first product from the chain development of a single monomer. It is formed by polymerizing caprolactam, which in turn is derived from cyclohexanone and hydroxylamine. The resin can be easily extruded to form film of varying degrees of translucency, in either an oriented or unoriented state. Its moldability is such that shapes likes bottles and complicated shapes can be formed on conventional molding equipment. Properties of resultant moldings include high strength, impact resistance, abrasion resistance, toughness, corrosion and solvent resistance and self-lubricating characteristics against metals or other plastics. An accompanying table indicates typical physical properties obtained from Plaskon 8200 moldings.

Advantages in molding

Molding the resin at low mold temperatures produces maximum impact strength or toughness with minimum shrinkage. As mold temperature increases 8200 becomes more rigid, but is said to remain non-brittle at a mold temperature of 200 F. This effect is the result of controlled crystalline structure permitting the molder or extruder to vary the finished product's physical properties in thin sections. Combination of high molten viscosity and controlled crystalline structure is said to give the material outstanding moldability. In addition, thick sections or large pieces can be molded with minimum voids since the nylon does not decompose or liberate gas during molding or extrusion cycles.

Parts molded from Plaskon nylon in natural color are opaque white. For short-run coloring, or where a few millimeters of color depth is sufficient, 8200 can be cold-colored after molding. For

SOME TYPICAL APPLICATIONS AND IMPORTANT CHARACTERISTICS OF PLASKON 8200

Properties / Applications	Str	Abrasion Resist	Toughness	Lt Wt	Self-Lubricating Char	Heat Resist	Flex	Chem & Corr Resist	Moldability	Can be Colored
Bearings	X	X	X	X	X				X	
Brush Holders			X	X		X			X	
Bushings	X	X	X	X	X				X	
Cable Coatings		X	X			X	X	X	X	X
Cams	X	X	X	X	X					
Coil Forms			X	X		X			X	
Housings	X		X			X		X	X	
Mono-Filaments	X		X			X	X	X		X
Valves			X	X				X	X	
Wire Jackets		X	X			X	X	X	X	X

molding fully colored pieces, coloring can be blended with the charge before molding. Where very deep colors are desired a master batch and a blending operation can be used. Easy recovery without development of color will permit close to 100% yield of material. Cutting and redrying techniques permit full recovery of sprues, runners and occasional spoiled parts.

Where it will be used

As indicated in an accompanying applications chart, Nylon 6 is suitable for use in a diversity of applications covering many industries. Some of the larger ones are mentioned here briefly:

Aircraft — Nylon-jacketed wire is finding wide usage in the aircraft industry, since it is resistant to heat, abrasion, and attack by gasoline and oil, yet remains flexible over a wide range of temperatures. Use of nylon in gears and cams is finding increased use and extruded and vacuum-formed parts for interiors are a possibility because of their light weight and ability to take impact and resist wear. Coloring is possible for desired effects.

Automotive — Nylon is being used for interior dome light shields, gears, bushings, bearings, cams, locknuts, brush holders, door latch parts, automatic lubrication systems and ball joints. Operational parts are quiet, self-lubricating and resistant to vibration, chemicals and heat.

Electrical—It is being used in coil forms, switch components, and for housings, instrument gears, bearings and cams.

Textile Machinery—Many gear applications for nylon in the textile machinery industry are valuable since lubrication can be eliminated. Other possibilities include picker blocks, bobbins, spools and loom pickers.

Business Machines—Among the many small part applications for nylon in business machines are bearings, gears, cams, bushings, rollers and slides. In the future, some housings may be made of nylon.

Consumer Goods—Though nylon is a relatively costly material it is being used for many types of consumer goods because of its good physical properties and its ability to be molded into finished parts. Molding to finished dimensions can eliminate machining operations.

PROPERTIES OF MOLDED PLASKON NYLON 8200

Property	Test Value	ASTM Test Method	ASTM Condition[a]
Tensile Strength		D638-52T	
Yield Point, psi	8500		A
Ultimate Tensile Strength, psi	12,000		A
Ultimate Elongation, %	300		A
Modulus of Elasticity in Tension, psi	300,000	D638-52T	A
Compressive Strength		D695-52T	
Yield Point, psi	Not Applicable		A
Compressive Failure, psi	11,000		A
Stress at 1% Deformation, psi	3000		A
Impact Strength, Izod ft-lb/in. of Notch	1.2	D256-47T	A
Flexural Strength, psi	10,000[b]	D790-49T	A
Deformation under Load, %	1.7	D621-51	122F, 2000 psi
Heat Distortion Temperature, F	136	D648-45T	264 psi
Hardness, Rockwell R Scale	118	D785-51	A
Specific Gravity	1.13	D792-50	A
Bulk Factor	2.2	D392-38	A
Dielectric Strength, v/mil		D149-44	
Short Time (0.1 in.)	420		A
Step-by-Step (0.1 in.)	390		A
Dielectric Constant		D150-47T	
10^3 cycles	4.5		A
10^5 cycles	3.9		A
Power Factor		D150-47T	
10^3 cycles	0.05		A
10^5 cycles	0.05		A
Volume Resistivity, ohm-cm	1.1×10^{14}	D257-52T	A
Water Absorption, %	1.6	D570-42	D-24/23
Coefficient of Linear Thermal Expansion/°F	4.6×10^{-5}	D696-44	A
Specific Heat	0.4		A
Thermal Conductivity, Btu/hr/ft²/°F/in.	1.7		A
Flow Temperature, F	419	D569-48	A

[a] *Letter designations indicate conditioning of specimens in accordance with ASTM D618-53.*

[b] *Specimen did not break.*

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Liquid polymer *before compounding.*

Five Grades of
Polysulfide Liquid Polymers

Find Use for

- *Sealants*
- *Flexible Molds & Patterns*
- *Modifying Epoxies*
- *Leather Impregnants*

by J. S. Jorczak and D. Dworkin, *Thiokol Chemical Corp.*

■ Unlike other synthetic rubbers, the polysulfides can be obtained commercially in the form of solvent-free liquid polymers—either straight or compounded. These materials can be cured in place at ordinary temperatures and with hardly any shrinkage. Although they have other specialized uses, these materials are most widely used for various types of sealing applications.

Polysulfide liquid polymers and compounds not only have favorable processing characteristics, but also produce cured rubbers with certain properties unobtainable in other synthetic rubbers and sealants. On the other hand, the cured materials also exhibit the only moderate mechanical properties usually associated with polysulfide rubbers in general.

On the plus side, cured polysulfide polymers and compounds have excellent resistance to oil and gasoline; excellent resistance to water swelling; good electrical resistivity; good resistance to sunlight, oxidation and ozone; low permeability to gases; good flexibility at temperatures as low as −65 F; good adhesion to a variety of materials; and good plastic flow under stress.

On the minus side, these materials have only fair tear resistance; fair flex life; fair resistance to compression set; poor resistance to cutting; poor abrasion resistance; and fair resistance to acids and alkalis. They also have relatively low heat resistance, although they can withstand temperatures up to 250 F for prolonged exposure and 300 F for intermittent exposure.

The polymers

Five different grades of polysulfide liquid polymers are available. They represent three different degrees of polymerization and, for each of two degrees of polymerization, two different degrees of crosslinking ability. This relationship is shown more clearly by the accompanying sketch.

The highest polymers, LP-2 and LP-32, are viscous, but the other grades are free-flowing liquids. The over-all viscosity range corresponds roughly to that between SAE 10 and SAE 60 lubricating oils. All grades are clear amber in color, neutral in pH, and have a specific gravity of about 1.27. The uncured polymers have a strong mercaptan odor. Other properties of the lower liquid polymers are shown in Table 1. Properties of LP-2 and LP-32 are not shown since they are generally used in the form of compounds rather than straight liquids.

Straight liquid polymers have two principal uses at present: 1) impregnation of leather for packings and oil seals, and 2) modification of epoxy resins. The lowest liquid polymer, LP-8, is also sometimes used in blends with the more viscous polymers.

Leather impregnation—Leather is impregnated by partly or wholly saturating it with a liquid polymer, then allowing the polymer to cure within the pores, usually at room temperature. The curing agent, generally a proprietary lead or cobalt salt, may be incorporated in one of two ways; it may be added to the liquid polymer itself before saturation, or it may be added to the leather before saturation by dipping the leather in a solvent solution of the salt.

These materials combine some of the resilience of rubber with the toughness of the interlocked fibrous structure of the leather. Impregnation also reduces the coefficient of friction and improves the sealing fit on slightly eccentric or oversize shafts. Operating temperature range for these materials is —65 to 200 F.

Several different types of impregnated leather packings and oil seals are manufactured. They vary from partially impregnated structures that simultaneously seal and lubricate to completely impregnated structures that are impermeable to many liquids and gases. Applications include standard shaft-type oil seals; low-pressure seals in contact with drycleaning solvents such as carbon tetrachloride, trichloroethylene, benzene and ketones; and pneumatic or hydraulic packings subjected to pressures of up to 15,000 psi.

Resin modification—Compared to straight epoxies, epoxy-polysulfide copolymers have far superior impact resistance, better flexibility, lower water vapor transmission, better wetting properties, lower cure shrinkage and lower temperature resulting from the exothermic curing reaction. Electrical and chemical properties are essentially those of the straight epoxies.

The copolymers are made by simply mixing the liquid polymer

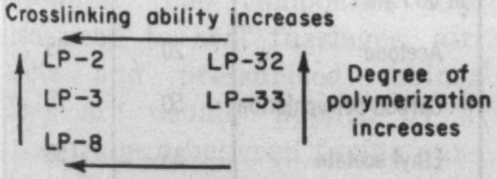
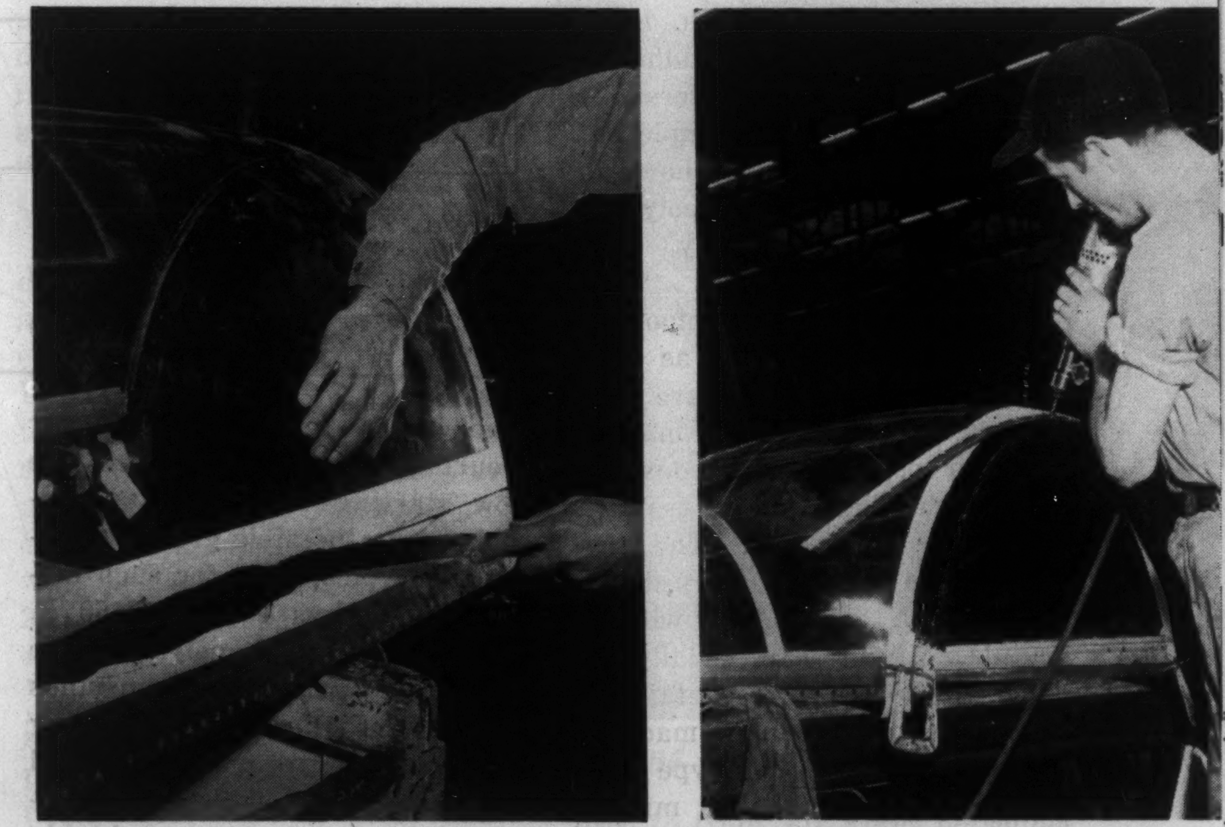

Crosslinking ability increases
LP-2
LP-3
LP-8
LP-32
LP-33
Degree of polymerization increases

TABLE 1—PROPERTIES OF LIQUID POLYMERS

Property \ Type	LP-3	LP-33	LP-8
Viscosity at 77 F (approx.), poises	10	15	3
Molecular weight (approx.)	1000	1000	600
Pour point, F	—15	5	—25
Flash point (open cup), F	418	401	360
Fire point (open cup), F	465	464	400
Moisture content (max), %	0.1	0.1	0.2



Sealing the bubble *for a jet fighter.* *(Minnesota Mining & Mfg. Co.)*

Cup packing *for pneumatic cylinder is made of leather impregnated with polysulfide liquid polymer.*

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with the liquid epoxy resin, then curing at room temperature in the presence of an amine catalyst. These modified epoxies have been used successfully for potting and casting, adhesives, laminates and coatings. Typical applications include embedding electronic components; tools and dies; bonding aluminum honeycomb structures; laminated glass-reinforced pressure bottles (where permeability is a serious problem); and flexible protective coatings for chemical process equipment.

Compounded polymers

In most applications, polysulfide liquid polymers are used in the form of compounds. Compounds may include pigments and other fillers for added strength, lower cost or color; resins for adhesive properties; and plasticizers for lower viscosity. Some simple but typical formulations are shown in Table 2. The lowest polymer, LP-8, is not ordinarily compounded.

TABLE 2—COMPOSITION OF TYPICAL LIQUID POLYMER COMPOUNDS

Function	Component	Type of Compound			
		LP-2	LP-32	LP-3	LP-33
Base	Liquid polymer	100	100	100	100
Filler	Carbon black (SRF) Titanium dioxide	30 —	30 —	— 50	— 50
Curing Agent	C-5[a] p-Quinone dioxime	15 —	13.1 —	— 7	— 7
Accelerator	Diphenylguanidine Sulfur	— —	— 0.1	3 —	3 0.1
Retarder	Stearic acid	1	1	—	—

[a] *50 Lead dioxide, 45 Dibutyl phthalate, 5% Stearic acid*

TABLE 3—MECHANICAL PROPERTIES OF CURED COMPOUNDS

Property \ Type	LP-2	LP-32	LP-3	LP-33
Hardness, Shore A durometer	45-50	40-45	40-45	35-40
Tensile strength, psi	450-550	450-550	300-500	300-500
Elongation, %	300-400	700-800	600-800	800-1100

The liquid polymer compounds are almost always used as two-part formulations which are mixed just before use. They may be fluid for pouring or viscous for troweling. The fluid mixes are the easier to handle. The two components can be stirred together with a metal or wooden spatula. Mixing can usually be done in the original containers, but larger mixes can be made in inexpensive change-can type mixers. Proportioning and mixing machines for continuous production lines have recently become available.

Fast-curing compounds are based on LP-2 and LP-32 polymers. Compounds having similar handling characteristics can be made with working life of 2-3 min and set time of 5-10 min, or with working life of 6-8 hr and set time of 20-24 hr. Although the curing reaction itself is exothermic, over-all cure time can be reduced considerably by heating the applied compound at a temperature in the 120-180 F range.

Where slower cures are permissible. compounds based on LP-3 and LP-33 are often used for pouring applications, since the low starting viscosity they provide makes possible greater fluidity. A typical cure for such materials requires 16 hr at 160 F.

LP-2 or LP-32 polymers are used in most troweling compounds because of the higher starting viscosity they provide. So-called "buttery mixes", which are somewhat thixotropic but not highly viscous, can be made by incorporating certain pigments, such as Calcene T or Bentone 34.

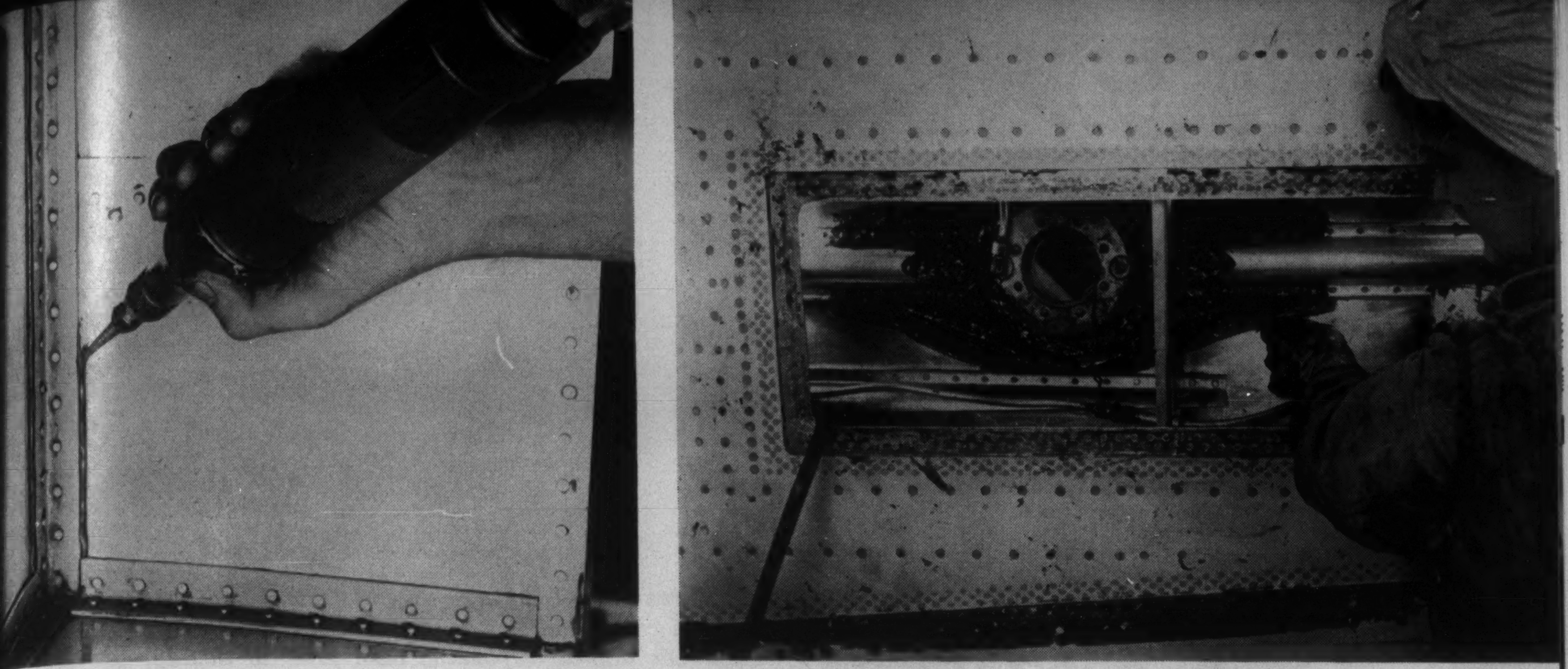
Choice between LP-2 and LP-32 or between LP-3 and LP-33 depends on the degree of flexibility desired in the cured rubber. The LP-2 and LP-3 materials undergo more crosslinking during curing and are therefore harder and stiffer than their counterparts.

TABLE 4—SOLVENT RESISTANCE OF CURED COMPOUNDS

Solvent \ Type	LP-2 and LP-32	LP-3 and LP-33
% volume increase after 1-mo. immersion at 80 F in:		
Acetone	20	45
Carbon tetrachloride	50	75
Ethyl acetate	35	50
Ethyl alcohol	5	5
Lubricating oil	3	3
SR-10 (diisobutylene aviation gas)	2	2
SR-6 (60/40 diisobutylene/aromatics)	11	12

Data on mechanical properties and solvent resistance of cured compounds are given in Tables 3 and 4. Unlike the uncured polymers, the cured rubbers have only a mild characteristic odor similar in intensity, though not in nature, to that of most natural and synthetic rubbers.

Polysulfide liquid compounds are currently used primarily as



Aircraft sealing *applications include the integral wing fuel tank (left) and the outboard tank filler neck (right).*
(Minnesota Mining & Mfg. Co.)

sealants. They are also used for flexible molds and patterns and in several other special applications.

Sealing — The usefulness of these compounds as sealants stems from their negligible shrinkage on curing, their adhesion to a variety of materials, their flexibility at low temperatures, and their ability to maintain a seal by plastic flow when the joint is severely stressed.

An important application is the sealing of riveted integral fuel tanks on large aircraft; the sealant must withstand severe vibration in addition to prolonged exposure to aliphatic and aromatic gasolines. The compounds are also used to seal fuselages, air ducts and pressurized cabins. They are usually applied by a pressure gun between faying surfaces, over rivet heads, and as fillets at joints.

The liquid polymer compounds make good caulking materials for wooden decks because of their ability to withstand the stresses imposed by rough seas and the alternate swelling and shrinking of the planks that occurs on wetting and drying. Resistance to spilled fuels is another advantage on aircraft carrier decks. Other marine caulking applications include transoms and hardware settings. In these applications, the compounds may be applied by pressure gun or by trowel. A primer is generally needed. Other marine maintenance applications include the sealing of propulsion shaft bearings on ships being "mothballed," and the repair of suction-discharge hose.

Casting compounds are used in electrical and electronic sealing applications where moderate dielectric characteristics are needed. Examples are electrical connectors for aircraft and guided missiles where failures might ordinarily result from vibration and other lateral stresses. Compounds with dielectric strengths of 200 to 225 v per mil and dielectric constants of 8.0 to 8.5 are typical.

Flexible patterns — Patterns suitable for heavy production of precision plaster molds can be made from casting compounds. These patterns reproduce details precisely, have good dimensional stability, and, being flexible, readily absorb the stresses accompanying the pouring and setting of the plaster molds. The technique offers a simple method for making complex patterns.

These casting compounds find similar applications in modelmaking and in the production of metal tools, dies and fixtures. The pottery industry uses them as molds for making ceramic shapes. Another application is relief maps and the molds from which they are made. These maps are used to train Air Force personnel in radar recognition of ground features (see M&M, Jan. 1955, p. 99).

Potting *electrical connectors.*

Printing rollers—Printing rollers with excellent resistance to quick-drying inks and lacquers can be spun from liquid polymer compounds. The uncured compound is spun at 500-1000 rpm in a cylindrical mold, after which the core is inserted and centered. The result is a dense, wear-resistant roll with Shore A durometer hardness of 20 to 45. Labor cost in this method of making rolls is much lower than for methods in which the roll is built up with rubber sheets.

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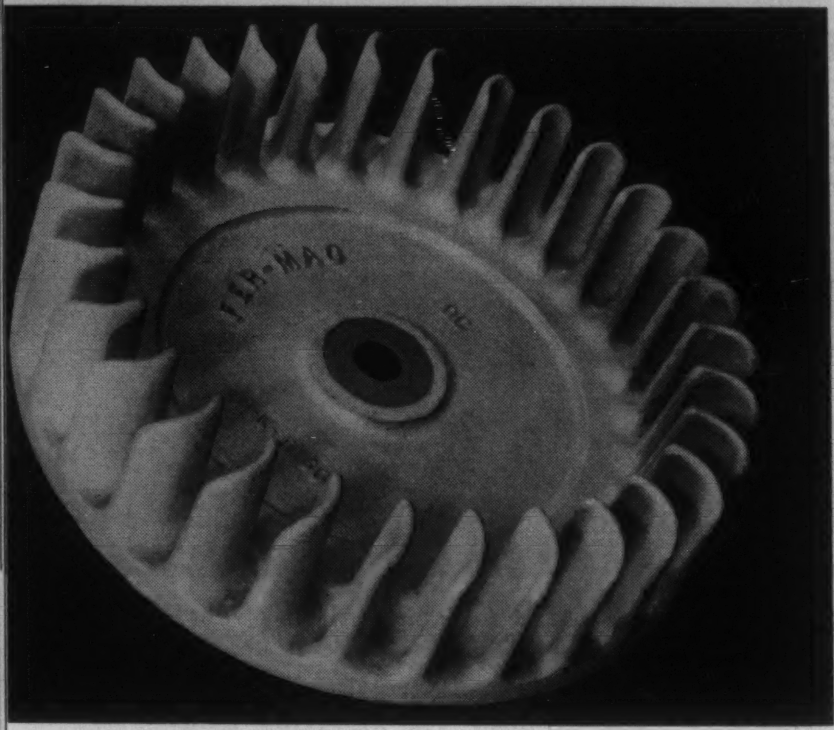
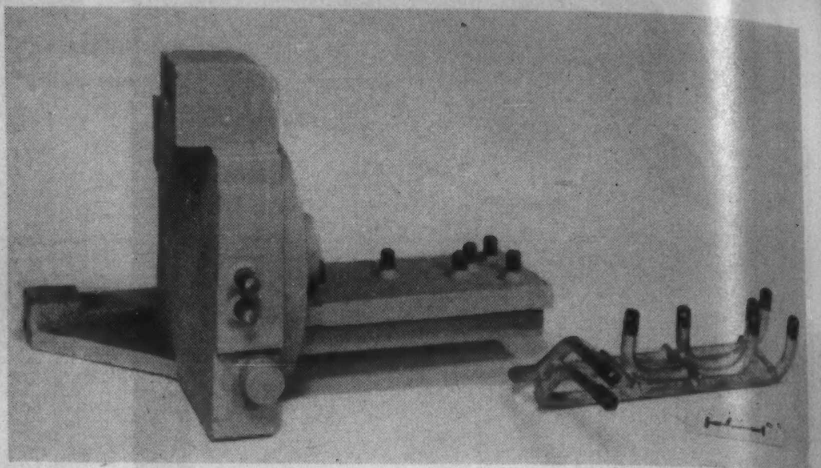


Steel hub *bonded in magnesium flywheel and cooling fan provides keyway to lock wheel to crankshaft and prevents deformation of magnesium in operation.*



Stainless steel tubing *is metallurgically bonded to a magnesium casting in this hydraulic manifold. Tubing at right has been dipped in bonding bath prior to casting.*

Magnesium-Ferrous Castings Solve Design Problems

Where weight is at a premium, Fer-Mag construction might be your answer. Brother to Al-Fin, the molecular bonding process is becoming commercially feasible in a growing number of places.

by H. W. Crusey, *Applications Engineer, Al-Fin Div., Fairchild Engine and Airplane Corp.*

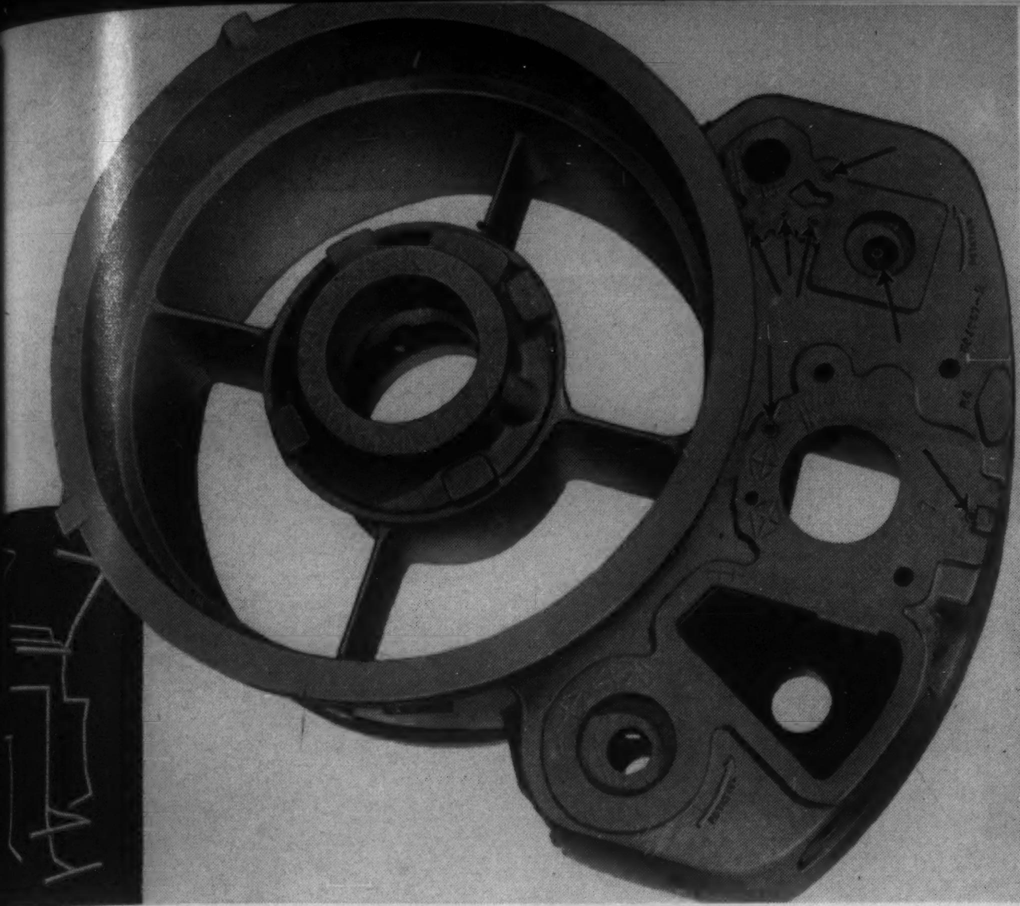
■ The combination of magnesium's lightness and steel's strength is ideal for applications such as airfoils for guided missiles, airborne altimeters and electronic components, engine flywheels, supercharger blower rotors, compressor cylinders and lightweight reciprocating engine components. An increasing demand for this type of component has led to the commercial development of the so-called Fer-Mag metallurgical bonding method. Weight reduction in the resultant part is not the only advantage of the process. It can solve many engineering problems involved in producing a part. The applications discussed show typical problems solved by the method.

Tubing systems

A common use for the Fer-Mag process is for integrally bonding stainless steel lubricating or hydraulic tubing in a magnesium casting. It eliminates many machine operations, precludes rejects or scrap from improperly drilled passageways and provides a unit with greater operating efficiency by allowing use of curved passageways rather than right-angle, drilled and plugged systems.

The hydraulic manifold shown in Fig 1 consists of a pre-formed cluster of small diameter stainless steel tubes bonded and cast into a magnesium housing. The intermetallic bond has an ultimate mean tensile strength of 12,000 psi and shear strength values ranging from 5500 to 7500 psi. Because the stainless steel is molecularly united to the cast magnesium, pressures as high at 3500 psi can be carried with no danger of leakage along the tubing o.d. at points of connection with other portions of hydraulic circuitry. Galvanic corrosion cannot occur along bond lines because there are no voids for accumulation of an electrolyte.

A similar application of Fer-



Magnesium casting *weighs 106 lb. Insert, lower left, shows stainless steel tubing assemblies before casting-in, while arrows show ends of tubing assemblies in completed casting.*

Mag bonding, but on a larger scale, is illustrated by the 106-lb magnesium casting shown in Fig 2. An integral gear casing for a jet engine forward frame, the casting is approximately 21 in. in diameter by 37 in. in over-all length, and 13 in. thick. Four stainless steel tube assemblies are bonded into the magnesium casting for circulation of lubricants.

Steel reinforcement

A flywheel blower for a 4-cycle gasoline engine is shown in Fig 3. A hardened keyway is necessary to permanently lock the flywheel on the engine crankshaft and prevent deformation of the magnesium under severe torsional loading. By bonding a steel hub to the magnesium casting, the flywheel can be securely attached to the crankshaft and rotational inertia can be provided by lightweight magnesium with optimum blower fin configuration. In addition, a minimum of labor and machine time is required to produce the component.

A guided missile control surface consists of a permanent mold cast magnesium airfoil with bonded-in alloy steel pivot shaft. The shaft is a simple tapered member. Forged or machined interlocks are not required, since the Fer-Mag bond has ample strength to resist loadings involved, even at supersonic speeds. Steel leading edges can also be bonded to the airfoil section for use at extremely high velocities where ram air temperature is sufficient to soften the magnesium. Weight of such leading edges can also be helpful in providing aerodynamic balance. Cast construction is also faster and more economical than conventional riveted sheet metal construction.

Light metals bonded to titanium

Fer-Mag and Al-Fin construction using titanium instead of ferrous metals is being developed for applications where the light weight and good high temperature strength of titanium can be combined profitably with magnesium or aluminum. To reduce production costs of titanium compressor stator blades, rolled airfoil section titanium blades can be produced with Fer-Mag bonded die cast magnesium footings. The light weight and heat-resistant characteristics of titanium coupled with the ease of casting magnesium offer an attractive alternative to the high-cost method of forging titanium blades.

Al-Fin construction is being used in high temperature aircraft hydraulic pump housings incorporating titanium with bonded-in aluminum impeller blade rubbing surfaces. The good high temperature physical properties of titanium are used in the pressure load-carrying portion of the housing while aluminum is used in the impeller cavity to provide a surface that will not score the impeller during run-in. The metallurgical bond provided by casting aluminum against titanium is necessary to prevent leakage of high pressure hydraulic fluid between the two metals.

Al-Fin vs Fer-Mag Bonding

Al-Fin bonding is a method of casting aluminum against steel or iron whereby a metallurgical bond is produced between the two metals. The steel or iron part is first dipped in a bonding bath; then aluminum is cast against the prepared surface. A cross-section of the resulting bond shows the ferrous alloy on one side, aluminum on the other, and a ferro-aluminum alloy at the interface.

Fer-Mag bonding is essentially the same, only magnesium is used instead of aluminum. The bonding bath is the same. A cross-section of the resulting bond shows the iron or steel on one side, magnesium on the other, and a binary alloy at the interface.

Though Fer-Mag bonding was demonstrated in the laboratory as early as 1943, it was not used commercially until 1952. It has been only relatively recently that the dividends paid by weight reduction have been high enough to warrant widespread use of magnesium in place of aluminum. Now with missiles and aircraft going faster and higher, every fraction of a pound counts and there are many applications where the strength of ferrous alloys can be coupled with the light weight of magnesium to provide worthwhile economies.

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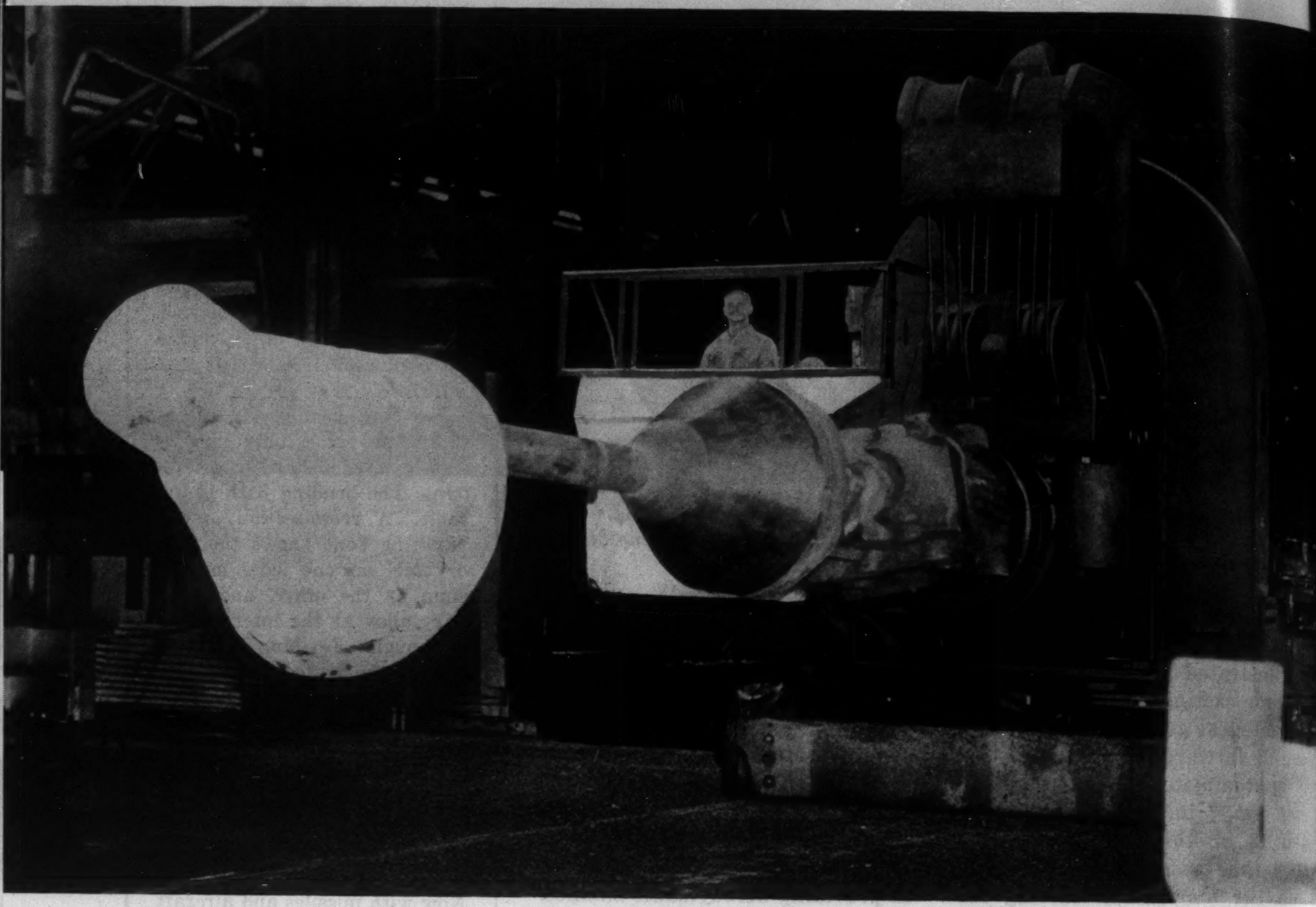
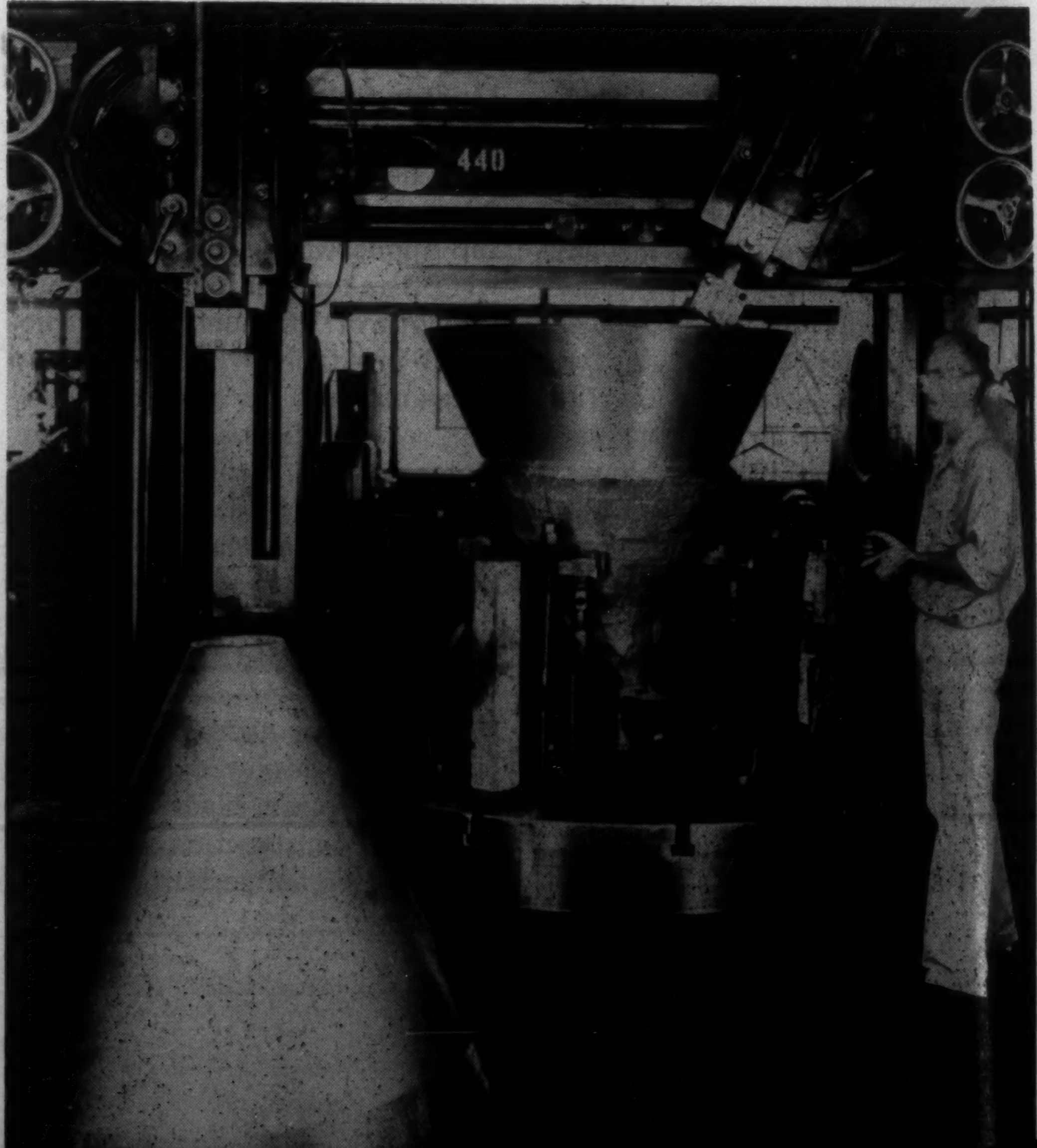


7000-Lb Forged Steel Cones The special mandrel shown was built for handling cone-shaped 7000-lb forgings. The hole in the small end of the cone, necessary for the mandrel, was closed by a subsequent forging operation. Forged by the National Supply Co., the cones are then finish-machined by that company to a 44-in. o.d. at the larger end, tapering to 8 in. at the smaller.



The jet age *has compounded the need for better high temperature alloys containing less strategic elements.*

(Republic Aviation Corp.)

Stainless steel test bars *being poured will be used to evaluate load carrying ability at elevated temperatures.*

(Cornell Aeronautical Lab.)

Modified 18:8 Stainless for Higher Temperatures

To conserve our supplies of such strategic metals as cobalt and nickel, we must find ways to raise the high temperature ceiling of our leaner alloys. Here is one step in that direction.

Based on a report by **Cornell Aeronautical Laboratory**

Editor's Note

This article is based on a report covering work done by Cornell Aeronautical Laboratory for the Navy Bureau of Aeronautics. It is not a conclusive report, but covers a segment of a continuing project to up-grade various types of steels to withstand higher service temperatures. The prime objective is to find relatively lean compositions suitable for jet aircraft service in the temperature range where alloys containing substantial quantities of strategic metals are currently being used.

The work covered by the report was based on austenitic chromium-nickel stainless steels of the 18:8 variety with and without molybdenum. Modifying elements consisted of titanium, boron, vanadium, zirconium, nitrogen and carbon. Evaluations were made of 100-hr rupture life at 1350 and 1500 F.

It should be emphasized here that the purpose of the study was to weed out desirable compositions on the basis of hot-strength properties only. Further metallurgical investigations are necessary before recommendations for trial service operation could be made.

■ For operating conditions involving high stresses with temperatures above 1200 F, almost complete dependence has been placed on superalloys containing substantial quantities of cobalt and nickel, as well as significant amounts of columbium, tungsten, chromium and molybdenum. However, in time of emergency it would most likely be necessary to use leaner alloy materials.

From a strategic-metal standpoint, austenitic chromium-nickel stainless steels are definitely lean materials compared to cobalt and nickel base alloys, and would comprise desirable substitutes if their hot-strength properties could be improved by heat treatment and minor alloy changes. Major effort has been concentrated on a study of austenitic stainless steels for use at temperatures above 1200 F where specifications are currently dominated by superalloys.

In the course of the work, approximately 150 compositions of 18 chromium-9% nickel, and 17

OPTIMUM COMPOSITION AND MAXIMUM HIGH TEMPERATURE STRENGTH OF MODIFIED STAINLESS STEELS

Type Composition	Composition (%) of Maximum Strength Alloy in Series	100-Hour Rupture Stress at 1500 F, psi	100-Hour Ductility at 1500 F, %	Solution Heat Treat Temp, F
18-8	0.15 C	7100	5.0	2100
18-8-Ti	0.15 C — 0.75 Ti	14,800	9.0	2300
18-8-B	0.15 C — 0.52 B	10,000	16.0	2100
18-8-Ti-B	0.15 C — 0.16 Ti — 0.50 B	11,800	14.0	2100
18-8-V	0.15 C — 1.24 V	10,800	10.0	2100
18-8-Zr	0.07 C — 0.20 Zr	8600	15.0	2100
17 Cr- 12 Ni — 2.5 Mo	0.30 C	9000	2.0	2100
17 Cr- 12 Ni — 2.5 Mo — Ti	0.15 C — 0.81 Ti	18,500	5.0	2300
17 Cr- 12 Ni — 2.5 Mo — B	0.30 C — 0.84 B	18,000	16.0	2200
17 Cr- 12 Ni — 2.5 Mo — Ti — B	0.15 C — 0.78 Ti — 0.15 B	20,600	2.0	2300
17 Cr- 12 Ni — 2.5 Mo — V	0.15 C — 0.59 V	11,000	36.0	2100
17 Cr- 12 Ni — 2.5 Mo — Zr	0.07 C — 0.10 Zr	10,000	21.0	2100

chromium-12 nickel-2.5% molybdenum stainless steels were tested at 1500 F and 1350 F. Solution heat treat temperatures of 2100 and 2300 F were investigated to determine their effect on high temperature strength of the alloy modifications.

Effect of additions

Additions of titanium, boron, zirconium, vanadium, nitrogen and carbon are all capable of improving 100-hr, 1500 F rupture strength of 18 chromium-9% nickel and 17 chromium-12 nickel-2.5%molybdenum stainless steels heat treated in the range of 2100 to 2300 F. Reasonable ductility is maintained after strengthening by the relatively high solution temperatures. The accompanying table indicates optimum analyses and the highest 100-hr rupture strengths obtained with various alloys tested at 1500 F. In general, maximum high temperature strengths increased as carbon levels were raised, with the largest strength increment occurring between 0.07 and 0.15% carbon. Rupture ductility was relatively unaffected, particularly for the alloy series containing combined titanium and boron additions.

High temperature strength of 17 chromium-12 nickel-2.5% molybdenum stainless steels is superior to that of 18 chromium-9% nickel steels under similar conditions of heat treatment and at similar alloy addition levels. All alloy variables provided the same degree of improvement in hot strength of the 18 chromium-9% nickel steels with a 2100 F solution treatment. For the 17 chromium-12 nickel-2.5% molybdenum alloys, boron provided the most significant increase in rupture strength of any single alloy addition.

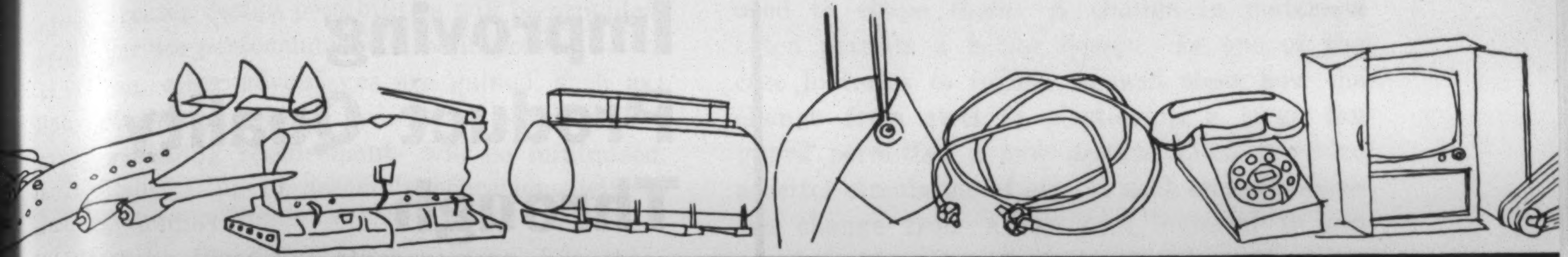
Combined additions of titanium and boron produced the most marked improvement in hot strength without sacrifice of rupture ductility following a 2100 F heat treatment. When titanium and boron were added jointly to the two types of steels tested, peak 100-hr rupture stress values occurred at progressively lower titanium contents as boron increased. Maximum rupture strengths of steels containing titanium and boron, either as single additions or in combined form, were greatly improved in most cases by utilizing higher heat-treat temperatures. These gains were generally accompanied by a decrease in rupture ductility, which was not as pronounced for boron steels as it was for those containing titanium.

In the titanium-bearing steels, peak 100-hr rupture strength values occurred at progressively lower titanium-carbon ratios with increasing carbon. In the presence of titanium or boron, addition of zirconium, vanadium or high nitrogen did not increase rupture strength of the two alloy groups at 1500 F.

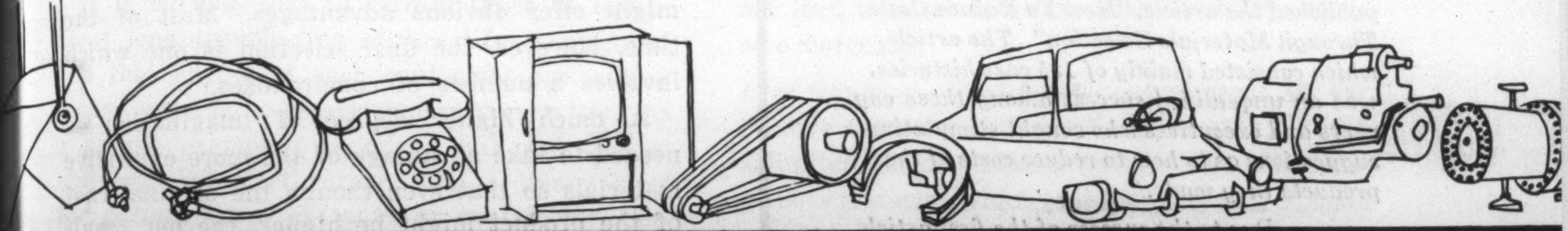
Hot-rolling characteristics of titanium-bearing steels were uniformly good. On the other hand, workability of boron compositions containing an excess of 0.40% boron at the 0.15% carbon level, deteriorated rapidly. Compositions containing boron at the 0.30% carbon level were extremely difficult to work, developing saw tooth edges during rolling.

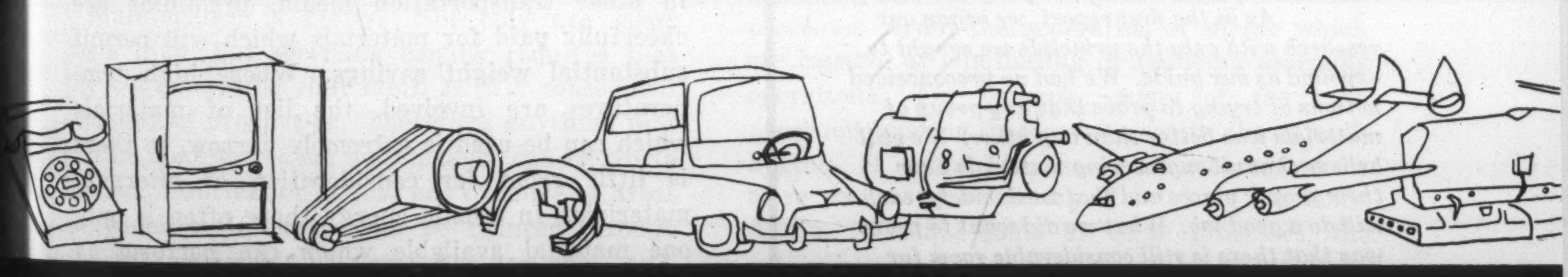
Future work

This alloy modification work resulted in raising the high temperature strength level for austenitic stainless steels into the lower end of the superalloy range, justifying continuation of the work. Alloys selected for further metallurgical investigation consist of a chromium-nickel-molybdenum composition with titanium, a chromium - nickel - molybdenum composition with boron and a third alloy to be chosen later. Future investigations would cover high temperature creep and rupture strength at 1200, 1350, and 1500 F under various conditions of heat treatment, and hot and cold working characteristics. Also included would be determination of room temperature tensile properties, aging and embrittlement characteristics and scaling and oxidation resistance.



Improving Product Quality Through Better Materials





A Special Report

Here are 79 case histories showing where and how intelligent materials selection resulted in improved parts and products. These examples will suggest how you can:

- *Lengthen service life*
- *Improve service performance*
- *Achieve better design*
- *Lower maintenance costs*

The Why and How Behind this Article

In May, 1954, Materials & Methods published the article, "How To Reduce Costs Through Materials Selection". The article, which consisted mainly of 135 case histories, was an unqualified success among those engineers and executives who sought stimulating suggestions as to how to reduce costs of the products they made.

Due to the success of the first article, it was decided to carry the case history technique a step further and show how other engineers were improving the quality and performance of their products by using better materials. In many cases the choices of materials were made in the face of the fact that costs—immediate costs, that is— were increased. However, greater costs for materials were justified by subsequent direct savings or by better performance which produced savings of a different type.

As in the first report, we began our research with only the principle we sought to expound as our guide. We had no preconceived notions of trying to prove that any group of materials was better than any other. We still believe that all engineering materials have their proper places and that used widely, each will do a good job. What we did want to prove was that there is still considerable room for improvement in many products and that imagination, properly channeled, can bring about many of these improvements.

We hope that this presentation will stimulate the imagination and also serve to educate both the engineers who develop products and the consumers who buy them that the least expensive goods are not necessarily the most economical.

This article represents the joint efforts of the entire staff of MATERIALS & METHODS *who obtained the cooperation of many of the leaders in American industry. We all thank those who gave us the much needed assistance.*

T. C. DuMond, Editor

Improving Product Quality Through Better Materials

Under most circumstances, engineers who are charged with the development of new products or the improvement of old ones must select materials which promise to give a maximum of performance and a minimum of cost. Usually this approach to materials selection results in the use of a relatively low cost material even though some other, more expensive material might offer obvious advantages. Most of the time, however, the final selection is one which involves a number of compromises.

A much higher degree of imagination is needed to take advantage of the more expensive materials so that even though the original cost of the product might be higher, the net result will be less expense to the ultimate user.

In considering the types of applications in which more expensive materials can be used with profit, we must first eliminate the special problems of high speed aircraft and equipment for atomic energy applications. In these fields certain materials provide exclusive properties which must be used almost without regard to cost. In the aircraft field and to a lesser degree in other transportation media, premiums are cheerfully paid for materials which will permit substantial weight savings. Where high temperatures are involved, the list of materials which can be used is extremely narrow, so there is little room for consideration of alternate materials. In atomic energy there often is only one material available which can perform as required. Thus, the cost angle is practically eliminated as a practical consideration.

Naturally there is no justification for going to a more expensive material or type of part unless there is strong promise that such a change will pay dividends. Careful analysis of the use to which the products are to be put is required. What reasons, then, are there for specifying a material or shape which you know is going to cost more at the outset?

The new material will provide longer service life.

Maintenance problems will be eliminated or reduced.

Greater design possibilities will be provided.

Service performance will be improved.

Often, other advantages are gained, such as:

Machining will be reduced or eliminated.

Finishing requirements will be minimized.

Fabricating or assembly operations will be simplified.

Perhaps there are other reasons, but those listed are sufficient to indicate the types of advantages which must be gained before such changes could be justified.

Let's explore a little more carefully some of the reasons listed. It will be noticed that many of the advantages sought have in common features which will reduce labor costs either during manufacture or during later use. Whenever the reduction does occur, it is extremely important.

Longer service life

It is obvious that in certain types of equipment long trouble-free service life is essential and that buyers of such equipment are willing to pay what is necessary to assure such life. As a simple example, we might cite the use of stainless-clad steel rather than ordinary steel for certain types of tanks or containers. Certainly the costs of the material would be higher, and probably the fabrication costs would be greater. However, the fact that the combined materials would last much longer should be sufficient justification for selecting the more expensive material. Not only will replacement costs be reduced, but so will the costs of making a new installation.

Lower maintenance

Maintenance is costly. Not only are labor costs high, but servicing usually requires that the equipment be shut down with a consequent stopping of production. Therefore, anything that can be done to reduce maintenance can be worth money. Lubrication is just one example of areas in which maintenance can be reduced through careful material selection. For example, self-lubricating metal powder bearings or nylon bearings or gears which require no lubrication can more than offset their additional cost in a comparatively short period. Among the case histories to follow are to be found several other examples of reduced maintenance problems brought about by better materials selection.

Design flexibility

Many materials which are quite satisfactory for a wide range of uses are somewhat restricted in their applications due to either to some inherent characteristics of the materials themselves, or by limitations imposed by the processes used to shape them. A change in materials often permits a better design. In one of the case histories to follow, we will show how the change from steel to plastics in a large fan guard permitted a new design which provided a better circulation of air. In such circumstances the change from a low cost material to one which is more expensive is easy to rationalize.

Other advantages

Reduced machining—Many of the newer methods of shaping materials have as their strongest selling points the fact that they can reduce the amount of machining required, if they do not eliminate machining entirely. Some of the processes are in themselves more expensive than competitive methods; others are restricted as to the materials which can be used with them. In the latter case, it usually happens, the processes do not lend themselves to use with the least expensive materials.

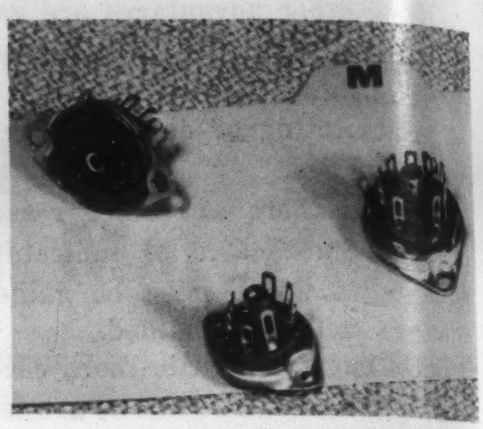
Less finishing—Most finishing operations are expensive and some of them offer protection for only a limited period. Thus a switch from a less expensive material, which requires a coating of some sort, to a more costly material, that can be used uncoated and still meet the service conditions, is logical. Where the strength and other characteristics of steel are required, the additional costs involved in changing from a low carbon steel to high strength, low alloy steel or stainless steel can usually be amortized over a relatively short period of time.

Simplified assembly—Die casting, shell molding, extruding and many other of the high production processes permit the generation of shapes which are capable of eliminating or reducing assembly operations. For example, many of the high precision casting processes permit the simplification of design to the point where two or more parts can be combined into one assembly. Again, in using some of these processes, the engineer is restricted to the use of relatively expensive materials. However, if properly applied, definite advantages are to be gained.

The case histories

Most of the principles expounded are backed up with the case histories which follow. As previously stated, these have not been selected with the object of making one material or process look good at the expense of another. Throughout industry today there is a constant loss and recapture of markets by various materials and processes. It is by this constant competition that better materials and methods are developed as improvements are made to regain lost markets.

1 Tube Socket



Low electrical losses, high dielectric strength and thermal stability at soldering temperatures are required for sockets for electronic tubes.

Old Low loss phenolic molding resin.

New Glass bonded mica (Mycalex 410X).

Advantages Gained The new material eliminated breakage during soldering and hook-up. The stability of circuits was improved due to the complete resistance of the new material to moisture absorption. No change in electrical circuitry was required, as the glass-bonded mica sockets matched the dielectric constant of low loss phenolic.

Source: *Mycalex Corp. of America, Inc.*

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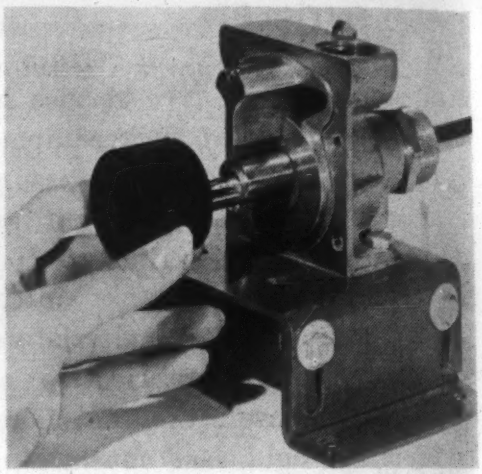
2 Rotary Pump Impeller



Impeller must have no water absorption, and must resist frictional heat which would lead to dimensional expansion. Dimensional tolerances must hold to 0.002 to 0.003 in. Strength must be adequate to displace 600 gal per hr against pressure of 150 psi and a suction lift of 26 ft.

Old All nitrile rubber.

New Polyvinyl chloride resin plasticized with nitrile rubber.

Advantages Gained Impeller maintains close tolerances, is free from frictional heat and expansion, leading to longer and more dependable pump life.

Source: *Goodyear Tire and Rubber Co.*

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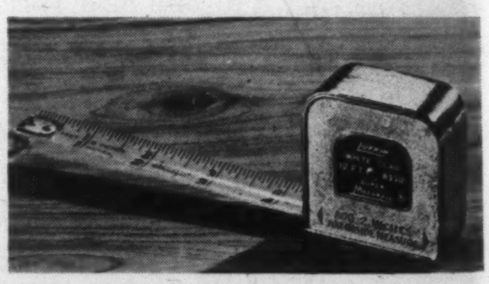
3 Tape Rule Case



Heavy-duty 2- x 2-in. case holds ¾ in. wide steel blade 12 ft long. Must resist impacts, withstand temperature extremes, have attractive appearance.

Old Steel stamping, spotwelded, soldered and chromium-plated.

New Magnesium die casting, chromium-plated and assembled with two corner self-tapping screws.

Advantages Gained Lighter in weight. Also lower manufacturing and assembly costs.

Source: *Lufkin Rule Co.*

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4 Paint Spray Gun Hose

Conveys liquids from compressor to spray gun. Must be flexible, light in weight, easily cleaned, able to withstand working pressures, and completely resistant to corrosive attack by hot paints and lacquers.

Old Synthetic rubber.

New Teflon tube reinforced with type 304 stainless wire braid.

Advantages Gained Practically unlimited life. Also less maintenance because of easier cleaning.

Source: *Resistoflex Corp.*

5 Telemetering Commutator Plate

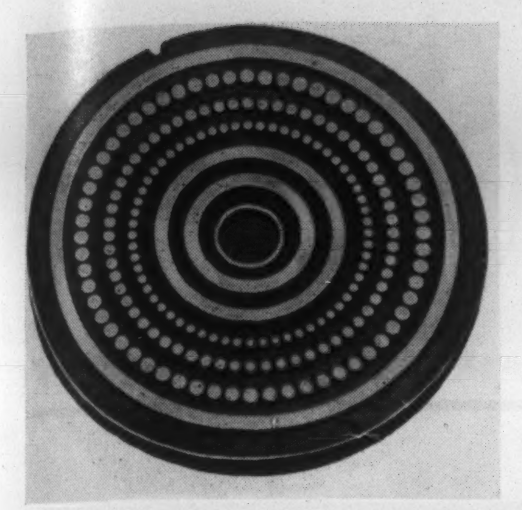

Plate is 3 in. in dia, ¼ in. thick. 180 metal contacts must maintain an optically flat alignment in plane of contact. The base material must be dimensionally stable, must withstand soldering temperatures, and must have excellent insulating qualities.

Old Fabric or linen reinforced phenolics.

New Injection molding grade glass-bonded mica.

Advantages Gained Test life increased from 4 to 200 hr. New material eliminated plate warpage when contacts were pressed in, maintained alignment during soldering, increased dimensional stability, reduced thermal expansion differential between insulator and conductor, since injection molded mica-based compound matches thermal expansion characteristics of metal used for contacts.

Source: *Mycalex Corp. of America, Inc.*

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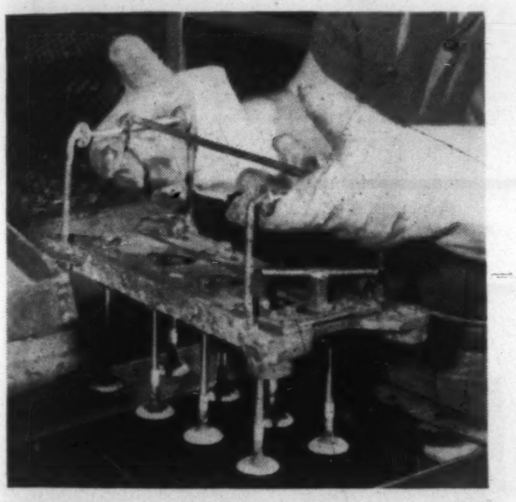
6 Automobile and Truck Valves



Intake and exhaust valves must withstand high stresses at high temperatures in the face of corrosive products and erosion from high velocity hot gases. The problem is increased with higher compressions and temperatures encountered in modern engines.

Old Valve steel.

New Same material, coated with aluminum, by means of Aldip process.

Advantages Gained Aluminum coating applied by dipping or spraying doubles the life of the valves. The coating protects the base material from corrosion and oxidation at high temperatures. Good coating adhesion is attained due to aluminum iron alloy layer formed at the interface of the coating and base material.

Source: *General Motors Corp.*

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7 Lightning Arrestor Case Caps

Old *New*

Cap must be weather resistant, and must offer good electrical insulation to prevent power line from shorting against the arrestor body.

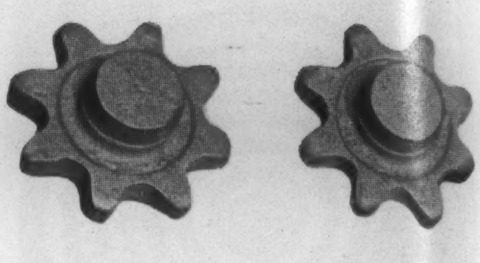
Old Porcelain.

New Glass-reinforced polyester molding.

Advantages Gained More precise molding permits a single lip to be shaped for the wire lead, eliminating the space formerly required around the cap's circumference, and thus improving the seal and reducing the amout of sealant needed at installation. The cap has much greater impact and shock resistance, and will not chip or break in service or during shipment and installation. Weight is reduced, and appearance improved.

Source: *Glastic Corp.*

8 Drive Sprocket



Used as a part of hopper feed roll drive mechanism where high stresses are created when large, hard lumps of material go through the hopper.

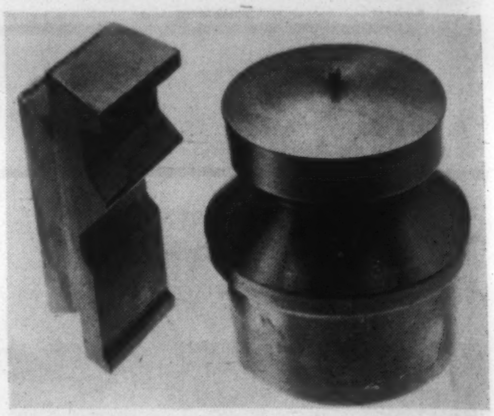
Old High strength bronze casting.

New Meehanite casting, heat treated to Brinell 470.

Advantages Gained Hardness, impact strength, and abrasion resistance extended life of the sprocket by three times. Damping qualities of material prevents build-up of resonant stresses.

Source: *Meehanite Metal Corp.*

9 Form Tool



This dovetail form tool must give long life in turning 18:8 stainless steel parts.

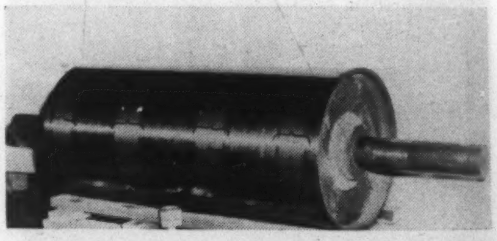
Old 18-4-2-8 cobalt high speed steel.

New A high carbon-high vanadium high speed steel (nominal analysis 1½ carbon, 12½ tungsten, 4¾ chromium, 5 vanadium, 5% cobalt).

Advantages Gained Greater number of pieces cut between grinds. Will cut 1250 pieces of stainless steel before resharpening is necessary as compared to the lesser performance of 240 pieces per grind obtained from 18-4-2-8 cobalt dovetail form tools.

Source: *Vanadium-Alloys Steel Co.*

10 Forming Roll



Cylindrical drum-type roll in plaster board forming machine is 24 in. in dia. by 56 in. long. Rolls used in pairs must withstand severe abrasive and wearing action.

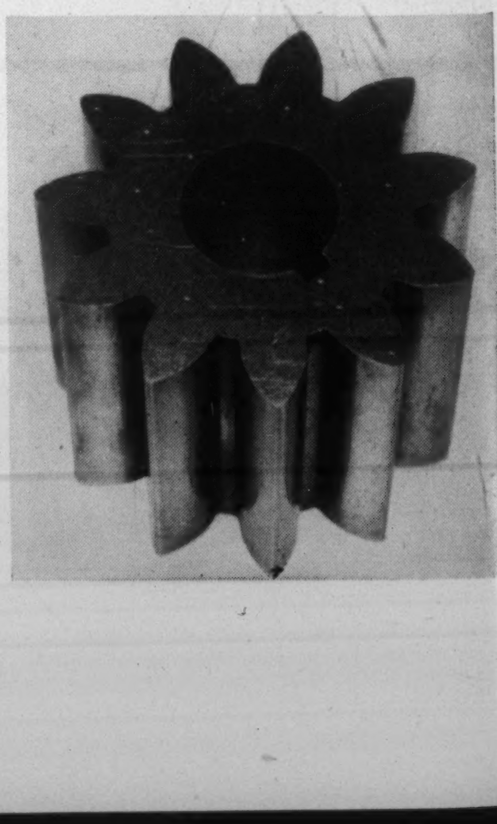
Old Plain carbon steel.

New Plain carbon steel hard-faced with a nickel-chromium-boron alloy powder.

Advantages Gained Previous normal life with one regrind was 12 to 16 mo. Service life now averages more than 6 yr between regrinds.

Source: *Wall Colmonoy Corp.; Hard Face Welding & Machine Co., Inc.*

11 Pump Gear



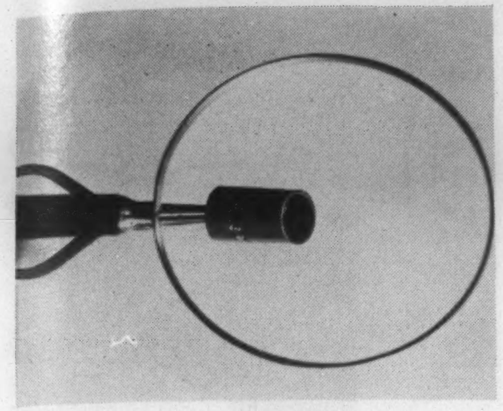
Oil pump gears 1¾-in. dia in various face widths from ¼ to 1¾ in. Must have: yield strength of 90,000 psi; particle hardness of Rockwell "C" 50 for wear resistance; close dimensional tolerances and smooth surface finish.

Old Machined from AISI 4615 bar stock and carburized.

New Fabricated from 4630-A prealloyed powder by pressing, sintering and heat treating.

Advantages Gained Better pump efficiency and quality through closer dimensional control and smoother surface finish of gears; no maintenance problems; expected longer service life; 20% cost reduction.

Sources: *Vanadium-Alloys Steels Co.; Keystone Carbon Co.*



12 Power Driven Socket Wrench Head

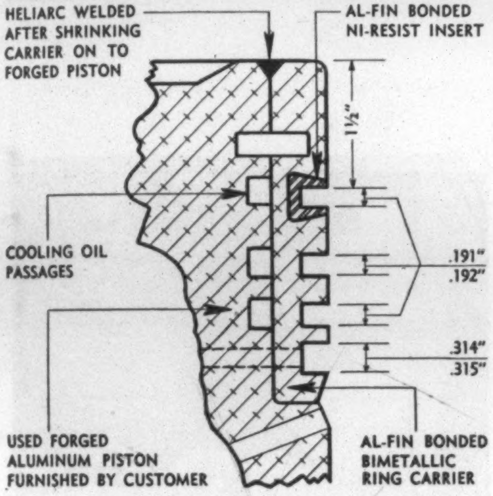
Head must withstand severe impact and abrasion caused by driving case-hardened, self-tapping screws.

Old Alloy steel.

New Cemented carbide inserts brazed into socket heads.

Advantages Gained Users report a socket head life 15 times that of conventional steel sockets. In test application, cemented carbide sockets operated constantly during a three year period with no sign of wear. Carbide sockets turned over 1,000,000 screws on one operation, while on same set-up only 10,000 screws were set with best conventional steel sockets.

Source: *Carboloy Dept., General Electric Co.*


HELIARC WELDED AFTER SHRINKING CARRIER ON TO FORGED PISTON
AL-FIN BONDED NI-RESIST INSERT
1½"
COOLING OIL PASSAGES
.191"
.192"
.314"
.315"
USED FORGED ALUMINUM PISTON FURNISHED BY CUSTOMER
AL-FIN BONDED BIMETALLIC RING CARRIER

13 Diesel Locomotive Pistons

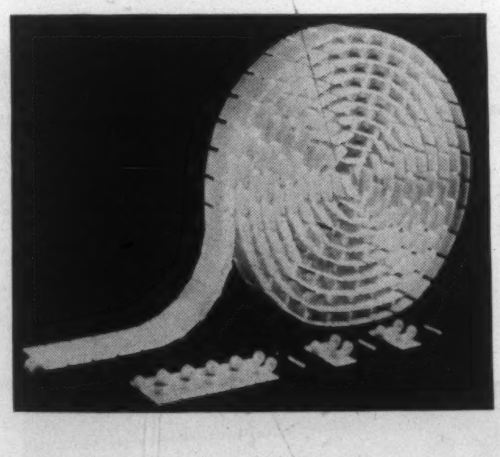
Pistons are 9 x 10½ in. Must withstand severe ring-wear encountered in diesel locomotive operation.

Old One-piece aluminum forging.

New Forged aluminum piston body. Ring carrier made of Ni-Resist, Al-Fin bonded to aluminum cast ring, which is shrink-fitted onto cut-back in forged piston, and heliarc-welded on dome.

Advantages Gained Tests to date indicate life of pistons increased 2 to 3 times. Maintenance costs are reduced.

Source: *Fairchild Engine and Airplane Corp.; Ohio Piston Co.*



14 Flat Conveyor Chain

Must carry cans, bottles and small cartons through washing, filling, capping, labeling and packaging operations.

Old Stainless steel.

New Molded nylon.

Advantages Gained No lubrication needed. Longer life. Less weight. Lower initial cost. Less breakdown time. Lower power cost due to less friction. Less breakage of containers due to smoother operation.

Sources: *Fenco, Inc.; E. I. Du Pont de Nemours & Co., Inc.*

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15 Washer Tub

Outer tub in automatic washer, approximately 21-in. dia by 11 in. deep. Must contain washing water through the washing cycle.

Old One piece sand cast aluminum.

New Deep drawn steel porcelain enameled, same form.

Advantages Gained More corrosion resistance, lighter weight, longer life. Also resulted in a cost savings of approximately $6.00 per unit.

Source: *The Maytag Co.*

16 Extrusion Torpedo

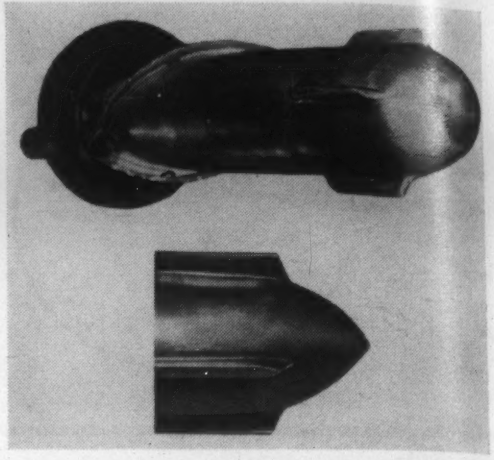
Part of an extrusion-type compound preheater used to heat an abrasive mixture of thermoplastic resins (400 F and 8000 psi).

Old Nose of torpedo originally made of SAE 3250 steel treated to Rockwell C-35; when this did not work, it was heat-treated to C-55. Then a tool steel nose was tried.

New Cobalt-chromium-tungsten alloy nose (Alloy No. 3).

Advantages Gained Life service now better than 10 to 1 over previously used material. After processing 45 tons of material, it was examined, found in good shape and put back in service. It is still in use and has handled over 130 tons of the abrasive mixture.

Source: *Haynes Stellite Co.*



17 Meter Housing

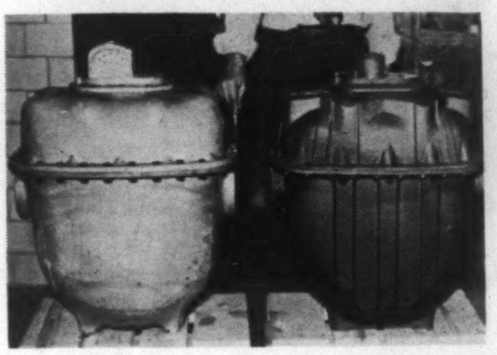
Castings used in large gas meters handling up to 5000 cu ft per hr at pressures up to 100 psi.

Old Cast iron.

New Cast aluminum with stainless steel wire thread inserts.

Advantages Gained Conversion to aluminum reduced the finished weight of the meter from 504 lb to 176 lb. However, aluminum is softer than cast iron and unprotected threads are subject to wear or stripping when the meter is connected to steel pipe. Use of stainless steel thread inserts protected the aluminum threads and provided a gas-tight seal without the use of a sealing compound.

Source: *Heli-coil Corp.*



New *Old*

18 Cam Follower

Cam follower ⅛ in. thick secured to an operating lever. Must resist wear at 1200 cycles per minute with loads up to 4 lb. Space limitations necessitated design of solid material.

Old Low carbon, cold finished alloy steel, copper hydrogen brazed to operating lever and entire assembly heat treated to 0.006—0.008-in. case depth.

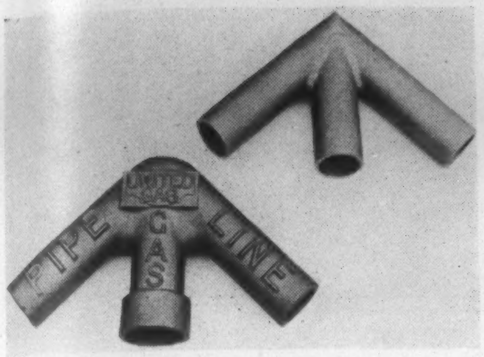
New Medium carbon, annealed and cold finished alloy steel, heat treated to Rockwell C 40-45 at a case depth of 0.003—0.005-in. Part is then riveted to the soft operating arm.

Advantages Gained Part has now been in operation for 4 years with no appreciable signs of wear; old parts required replacement after only several months of service. Because part is located in a rather complex mechanism, the increase in service life has eliminated a difficult maintenance problem. Using a material with a slight increased cost and then mounting and assembling by a less expensive method, a better part was produced at a decrease in cost of 31%.

Source: *International Business Machines Corp.*

Old

New



19 Vent Riser Cap

Cap must protect the vertically exposed end of the gas pipe line vent riser pipe and still allow free exit of gas which might accumulate. Also, it must clearly indicate that it is a gas line auxiliary part, resist corrosion and be tough and resist chance impact.

Old Three short lengths of pipe, cut to shape and welded together (top).

New Malleable iron casting (bottom).

Advantages Gained Presents the appearance of a useful functioning part, plainly warns that it is a component of a gas pipe line and has improved corrosion resistance.

Source: *Malleable Founders' Society*

20 Pipe for Materials Handling

Pipe is used in pneumatic conveyor for handling such abrasive materials as silica, sand and borax. The materials pass through pipe at high rates of speed.

Old ¼-in. rubber lined 6-in. carbon steel pipe.

New High nickel alloy cast iron, 5 in. i.d. with ½-in. wall thickness.

Advantages Gained New pipe has 38 times longer service life with 80% less contamination of charge into furnace.

Source: *International Nickel Co., Inc.*

21 Guide Rail

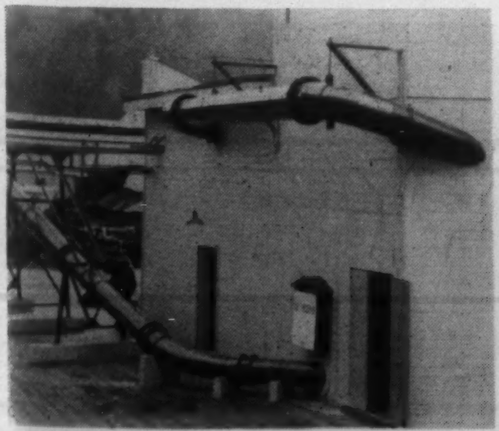
Rail used in pickling tank must resist abrasion from racks passing along rail and corrosion from acid spray (20% sulfuric acid at 165 F).

Old A high alloy steel; then rubber coated steel.

New Nickel-base corrosion-resistant alloy ("Hastelloy" alloy C).

Advantages Gained Corrosives rendered high alloy steel rails useless in two months. Abrasion rubbed off rubber coating and acids attacked steel underneath. The rubber-coated rails lasted 3 to 4 mo. The nickel-base alloy rails lasted three years.

Source: *Haynes Stellite Co.*



22 Tubing Bends

Used in pneumatic conveyor systems to withstand abrasion caused by blown wood chips passing from storage bin to pulp kettles.

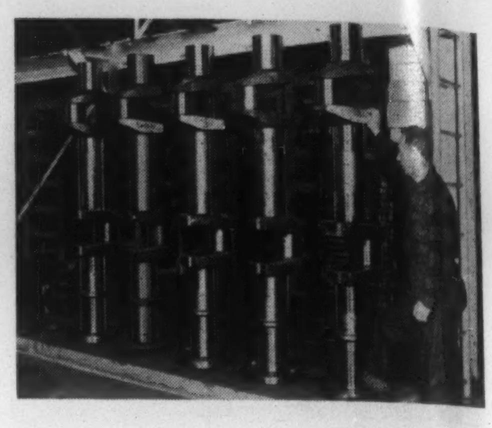
Old Plain steel bends.

New Porcelain enamel lined steel bends.

Advantages Gained Life of bends increased 12 to 14 times; downtime for replacing worn bends greatly reduced.

Source: *Erie Enameling Co.*

23 Large Engine Crankshaft



Shafts are used in engines, pumps, and compressors. Must have high strength, good wearing qualities and good machinability.

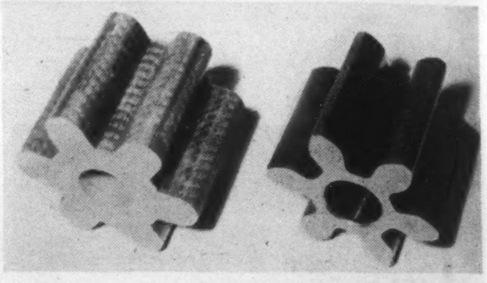
Old Forged steel.

New Cast ductile (nodular) iron.

Advantages Gained The mechanical properties of the cast ductile parts closely match those of the forged form and provide easier fabrication. Also, higher "notched" bar endurance limits are attained.

Source: *International Nickel Co., Inc.*

24 Priming Pump Rotors



Two of these rotors, 3 to 4 in. wide, 3-15/16-in. o.d. used in each pump.

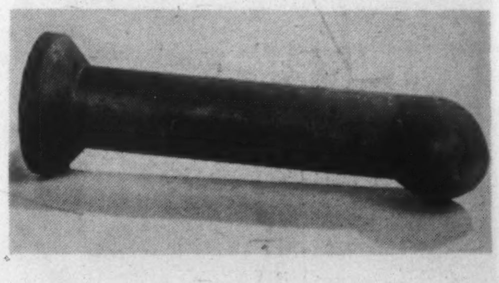
Old Sand cast from 88 copper-10 tin-2% zinc alloy.

New Continuously cast from same alloy.

Advantages Gained Part is formed in a shape closely approximating the finished form and only two machining cuts, one rough and one fine, are required to shave the rotor teeth to final dimensions. Since yield strength, impact strength and fatigue strength are significantly higher in continuous-cast bronze than they are in sand cast, the pump can withstand higher positive pressures.

Source: *American Smelting & Refining Co.*

25 Spray Nozzle



Nozzle is used in continous process for spraying a 15% solution of sulfur dioxide in water at a temperature of 150 F into a cooling chamber—temperature in chamber around the nozzles about 1700 F. Part required to withstand corrosion, erosion and high temperature.

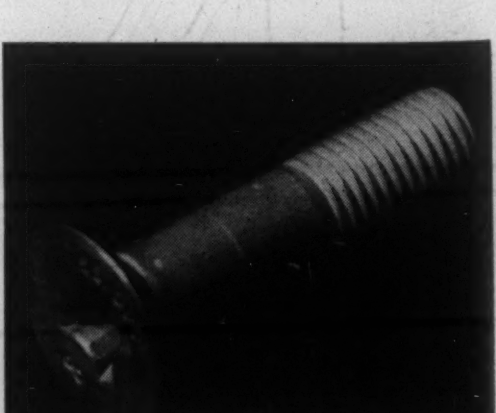
Old Corrosion resistant metals.

New Bonded silicon carbide.

Advantages Gained Metal nozzles had an average life of less than 2 mo; silicon carbide nozzles have averaged 3 yr and some have been in service 5 yr with no signs of wear.

Source: *Carborundum Co.*

26 Machine Screw



Flat Phillips head machine screw for aircraft service meeting specifications of 125,000 psi tensile strength and 95,000 psi shear strength.

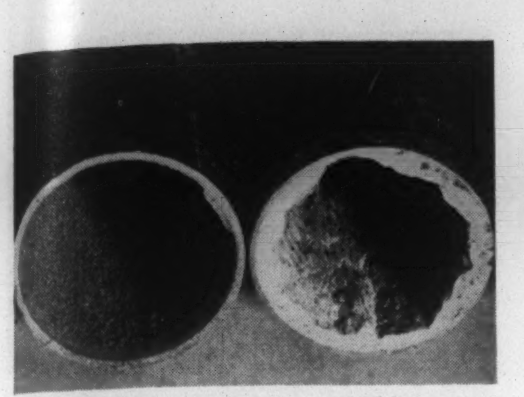
Old Alloy steel.

New Titanium.

Advantages Gained Increased corrosion resistance, 44% reduction in weight and less maintenance because of longer service life.

Source: *H. M. Harper Co.*

27 Preheater Tubing



Tubes installed in a counterflow boiler air preheater in which the inlet air temperature was 100 F and the outlet temperature 250 F. Fuel being burned was strip coal having a sulfur content of 3 to 8%.

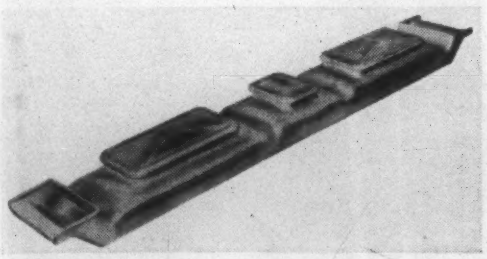
Old Plain steel tubes.

New Steel tubes with interior surfaces coated with a fused boro-silicate coating.

Advantages Gained After 6 months service, steel tubes were scaled and pitted under scale, coated tubes showed no attack. Ease of removal of fly-ash and elimination of scaling greatly extended the life of tubing in this application.

Source: *Barrows Porcelain Enamel Co.*

28 Heat Treating Lead-Pan



Pans are used in annealing and tempering wire. They are exposed to molten lead at temperatures of 1600—1650 F.

Old Cast iron with wall section thicknesses of 2—3 in.

New Cast iron-chromium-nickel alloy (ACI Type HH).

Advantages Gained Service life increased 13 times over previous cast iron pan. Avoids failure encountered with cast iron pan which often caused lead to spill on the support. Changeover also permitted a redesign which resulted in considerable reduction in weight since wall sections could be much thinner. Thinner wall sections permit much more rapid heating of molten lead.

Source: *Alloy Casting Institute*

29 Spray Nozzle

Part used in spraying hydrofluosilicic acid at 150 F. Must resist corrosion and abrasion, the latter resulting from the tendency of silica to precipitate from the solution.

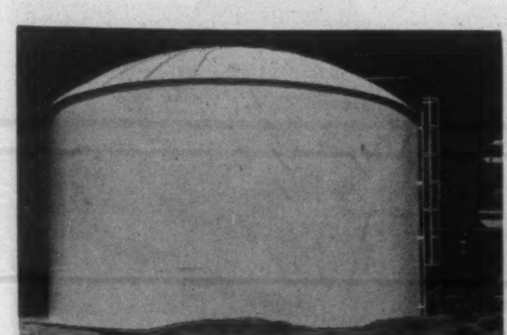
Old Bronze.

New Silicon-nitride bonded silicon carbide.

Advantages Gained Metal nozzle lasted 3 weeks, refractory nozzle still in service after 3 mo with no perceptible changes. Since it was necessary to change the nozzle when the outlet enlarged, the longer life of the refractory has reduced the frequency of checking required and cut maintenance costs.

Source: *Carborundum Co.*

30 Storage Tank



Tank used for the storage of liquid ammonium nitrate. Required to resist corrosion by the chemical.

Old Carbon steel tank internally coated with a plastic film.

New Stainless-clad steel tank.

Advantages Gained Life of tank increased, maintenance and repair greatly reduced since inner surface is less susceptible to damage during inspection and cleaning than a coated surface.

Source: *Lukens Steel Co.*

31 Mold Cavities for Die Casting

Part must reproduce intricate shapes in original designs to be transferred to zinc die castings and must have the ability to withstand pressure and resist erosion by the molten zinc alloy.

Old Machined steel cavities.

New Pressure cast beryllium copper cavities, chromium plated.

Advantages Gained Cavities cast from beryllium copper follow designs more accurately than do those produced by machining particularly if the conformations are complicated or nonsymmetrical. As a result there is a significant reduction in bench time in readying the molds for production.

Source: *Manco Products, Inc.*

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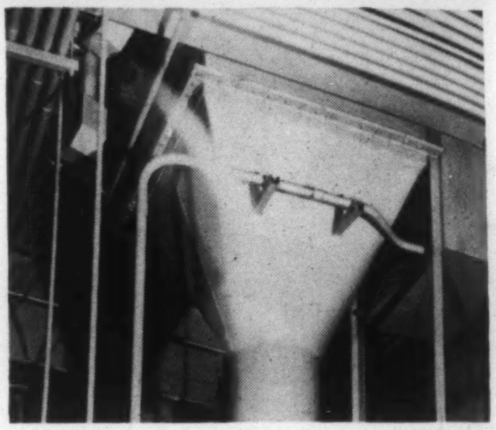
32 Hopper and Chute



Equipment required to resist corrosion and abrasion by free-flowing coal.

Old Fabricated from carbon steel plate.

New Fabricated from stainless-clad steel plate.

Advantages Gained Service life expectancy extended greatly because of increased corrosion resistance, maintenance reduced. Stainless cladding develops a high polish and provides a low coefficient of friction.

Source: *Lukens Steel Co.*

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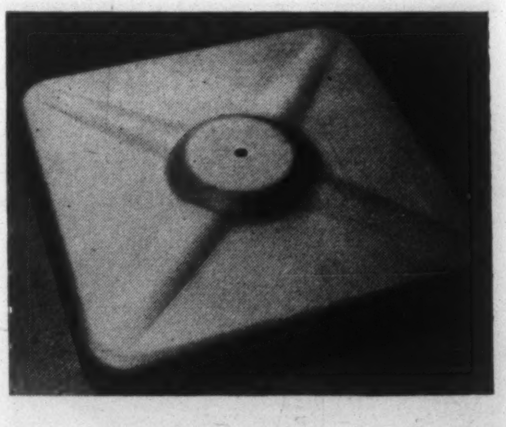
33 Table Base



Part is a base for a single stanchion table which must be durable, light weight in the size required for stability and have a pleasing appearance.

Old Steel casting partially smoothed by grinding.

New Pressed steel plate.

Advantages Gained Breakage in production and use reduced 50%, weight cut in half, grinding eliminated, unit cost reduced by 33¢.

Source: *By-Products Steel Co.*

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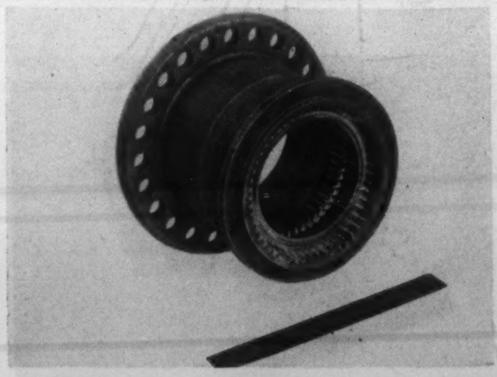
34 Housing



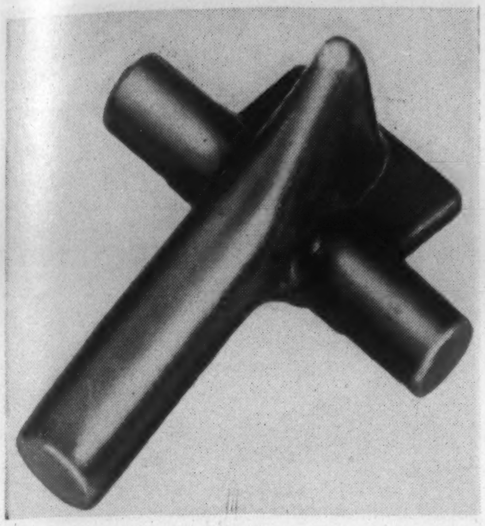
Front housing for jet engine starter is approximately 4¾ in. in dia and 4 in. high. Encloses gear train, clutch and starter jaw advance mechanism. Annulus gear, machined directly in housing, must withstand 800 starting cycles at given loads to meet specifications.

Old Fabricated from 8740 steel forgings.

New Fabricated from 7075-T6 aluminum forgings.

Advantages Gained Weight reduction which is of primary importance in aircraft application. Wear resistance of aluminum gear teeth is satisfactory.

Source: *Eclipse-Pioneer Div., Bendix Aviation Corp.*



35 Clamp Bracket

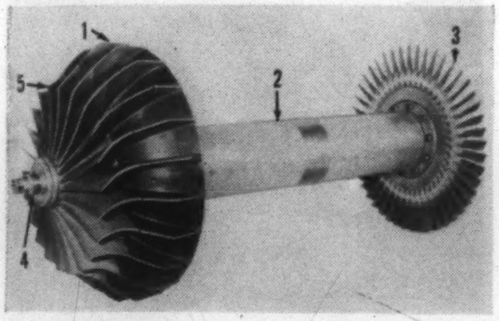
Part forms key part of trigger latch for cultivator. Bracket is 3½ in. long and 3¼ in. wide. Must withstand leverage force and shock encountered in holding cultivator tool bar in position.

Old Weldment made up of 3 pieces of flat bar stock.

New Forged in one piece of 104SC steel.

Advantages Gained Longer life due to increased strength of forging. Production rate increased 60%; only simple drilling operation necessary after forging.

Source: *Drop Forging Assn.*



36 Jet Engine Compressor Impeller

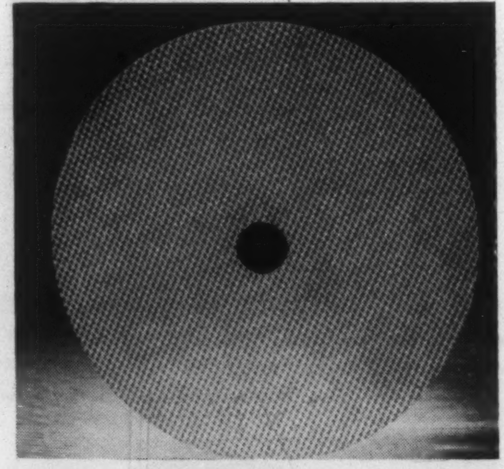
Approximately 18 in. in dia, J-44 compressor impeller is used in target drone engine which receives repeated immersion in sea water. Impeller must withstand temperature of about 300 F in operation and resist salt water corrosion due to immersions of several hour duration before drone is retrieved.

Old Forged magnesium with dichromate treatment.

New Forged magnesium with dichromate treatment and phenolic varnish coating approximately ½ mil thick.

Advantages Gained Part without coating was good for only 1 immersion, whereas coated impeller permits at least 10 flights and subsequent immersions before overhaul. Only rinsing is necessary between flights. Coated part can be stored for long time in marine atmospheres without reconditioning prior to use.

Source: *Engine Div., Fairchild Engine and Airplane Corp.*



37 Filter Screen Plate

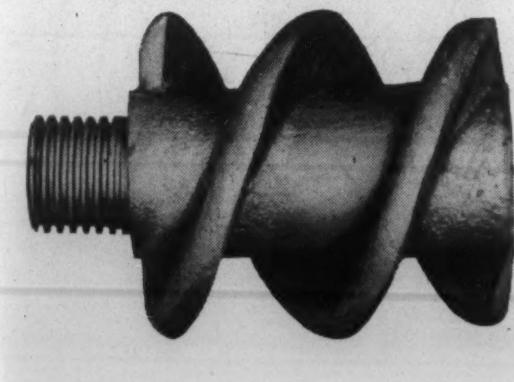
Plate provides reinforcement on which is pressed a pulp material to form filter cake.

Old Tinned copper wire cloth, 14 x 40 mesh.

New Rigidized and perforated stainless steel sheet.

Advantages Gained Life of plate increased. When old cake was removed from copper screen material, wires broke making formation of new cake difficult. New perforated plate lasts indefinitely and simplifies formation and removal of filter cake.

Source: *Rigidized Metals Corp.; Arnold Equipment Corp.*



38 Augur

Clean-out augur for retort furnaces in a zinc smelting plant must withstand continuous service temperatures of 1600 to 1800 F.

Old Iron.

New Low alloy cast steel.

Advantages Gained Life of new part is in excess of 100 hr, while old form lasted from 16 to 20 hr. Higher cost of cast steel compensated by lengthened life of part.

Source: *Steel Founders' Society of America*

39 Pump Housing

Water pump housing for gas turbine water injector system must withstand erosion from water flowing through volute and venturi at high velocity.

Old Cast aluminum.

New Cast aluminum alloy with Al-Fin bonded investment cast stainless steel venturi and volute.

Advantages Gained Bonded-in insert prevents cavitation erosion and abrasion of venturi and volute. Metallurgical bond prevents separation of aluminum and steel from differential expansion.

Source: *Al-Fin Div., Fairchild Engine and Airplane Corp.*

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40 Roller Bearing Separator

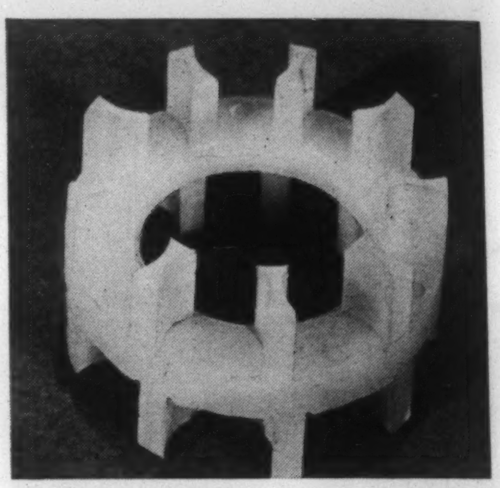
Approximately 1½ in. in dia, separator must hold precision ground rollers in place, yet prevent binding which would result in skidding and wear of rollers.

Old Steel, brass and Micarta, machined to close tolerances.

New Injection molded nylon.

Advantages Gained Considerable increase in life of bearing and cooler operation.

Source: *Bell Aircraft Corp.*



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41 Oil Filter Element

Center tubes of element are 2 in. in dia and must be strong enough to withstand pressures encountered in high speed diesel lubrication systems.

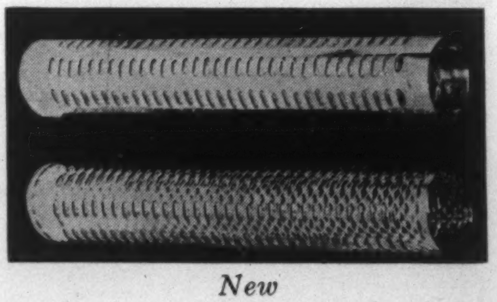
Old Tin plate.

New Rigidized tin plate.

Advantages Gained Strength of core is increased 100% with accompanying decrease in weight (from 195 to 135 lb). Improved field performance and ease of manufacturing.

Source: *Rigidized Metals Corp.; Engine Life Co.*

Old



New

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42 Jet Engine Combustion Chamber

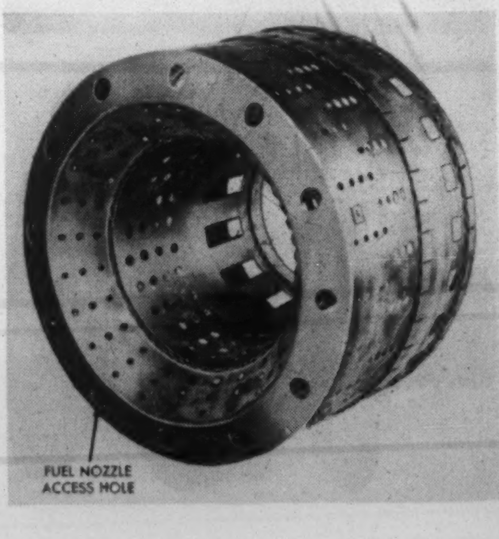
J-44 turbojet combustion chamber, approximately 20 in. in dia by 15 in. long, must withstand combustion temperatures in excess of 1500 F as well as erosion from fuel-air mixture passing through chamber.

Old Fabricated of stabilized types 347 and 321 stainless steel.

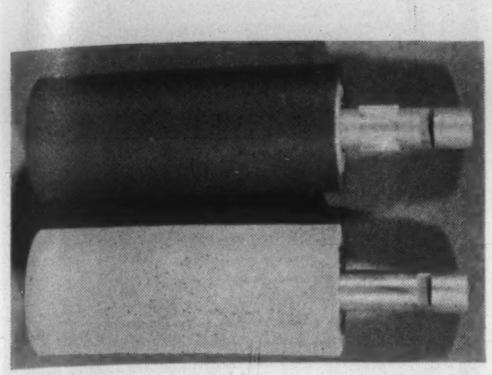
New Fabricated with Inconel X in critical areas and stainless steel in non-critical.

Advantages Gained Old form allowed operation for 12½-hr qualification time. New form presently permits 50-hr operating time, with possibilities of extending operation to 150-hr qualification.

Source: *Engine Div., Fairchild Engine and Airplane Corp.*



43 Ink Transfer Roll



Rubber molded on metal cylinder. Diameter is 1.000 ± 0.005; length is 2.534 ± 0.015. Must provide good ink transfer and resist deterioration from ink.

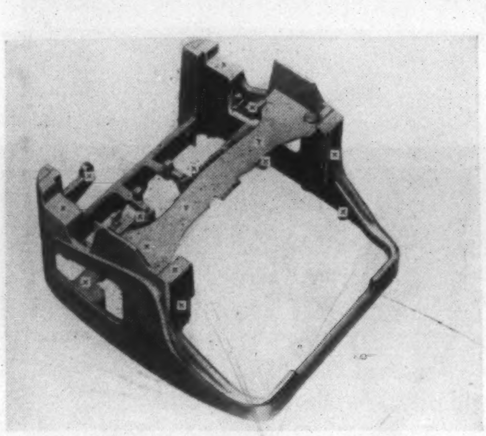
Old Rubber molded on steel sleeve. Bronze bushing pressed into sleeve at each end. Part revolves on steel shaft.

New Molded a new rubber material on aluminum sleeve. Shaft on which part revolves is provided with two grooves to accept split nylon bushings. Nylon bushings replace old bronze bearings.

Advantages Gained Part remains dimensionally stable since ink has no appreciable effect on new rubber. Nylon bearings prevent roll from freezing on shaft. This condition was evident on previous design because of collection of ink, dusts, etc., at bronze bearings. Improved printing on documents because of more even transfer of ink.

Source: *International Business Machines Corp.*

44 Typewriter Frame



Frame is used as outer mask as well as integral structural part of machine. Pleasing appearance and light-weight are desirable.

Old Fabricated from 6 iron sand castings.

New One-piece aluminum die casting.

Advantages Gained Improved appearance, reduced weight and reduced assembly and finishing operations and thus costs.

Source: *American Die Casting Inst.; Underwood Corp.*

45 Die Model

Die model for automobile roof must be dimensionally stable during changing moisture conditions over periods of a few months to several years.

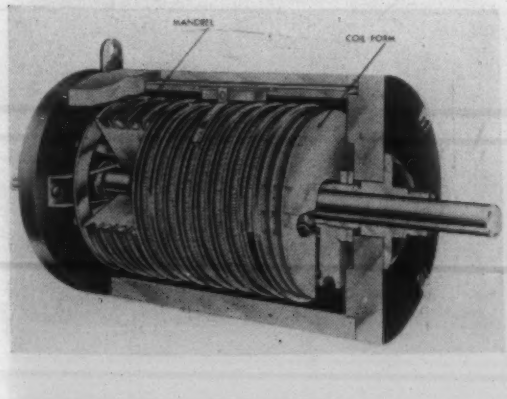
Old Honduras mahogany.

New Honduras mahogany veneer impregnated with 30% (by weight) phenolic resin. Treated veneer is laminated to form model.

Advantages Gained Impregnated mahogany changes dimensionally 65% less than untreated wood. Treating also improves resistance to chemicals, decay and heat.

Source: *Forest Products Lab., U. S. Department of Agriculture*

46 Delay Line Coil Form



Electromagnet coil form must have high dielectric strength, form stability and low moisture absorption.

Old Machined from rod of phenolic laminate.

New Machined from rod of nylon.

Advantages Gained Loss of rise time previously encountered was eliminated, and current losses were reduced.

Sources: *The Polymer Corp.; Helipot Corp.*

47 Fan Blade Guard

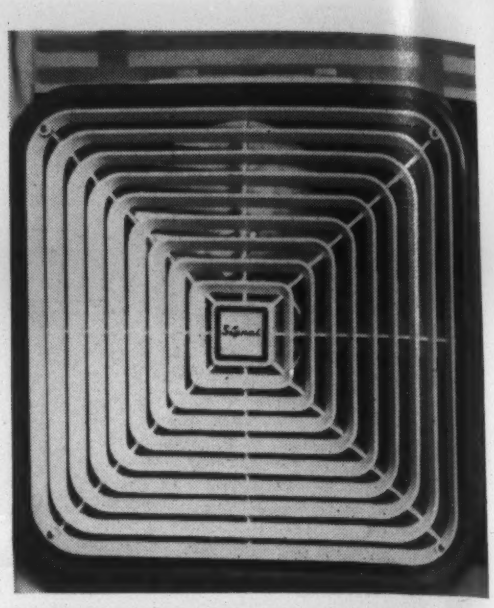
Must cover opening 21 in. square, offer minimum restriction to air flow, be easily removed for cleaning, and withstand jolts during shipment.

Old Grille of 13-gage steel wire spaced ½ in. and joined to frame of 6-gage steel wire.

New Concentric square louvers (pitched at angle of 30 deg to axis of fan rotation) made by injection molding high-impact polystyrene.

Advantages Gained New part permits better air circulation, has "air-conditioner look" for sales appeal and can be made in various colors. Improvements obtained with no increase in weight or cost.

Sources: *Signal Electric Corp., General American Transportation Corp.*



48 Rod Mill Guide

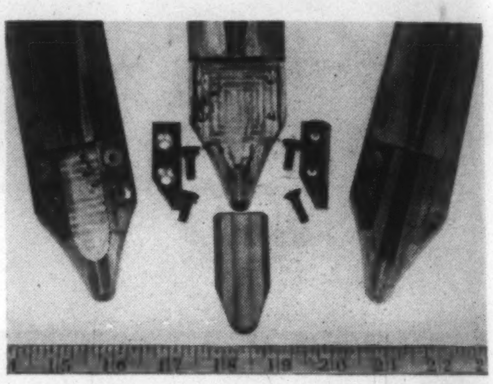
Must withstand wear by hot (1600-1800 F) wire moving at speeds of 40-60 mph. Must also resist shock and destructive oxidation, and retain useful strength at high temperatures.

Old Cast brass or steel.

New Cemented titanium carbide inserts mechanically held in guide halves machined from cast brass.

Advantages Gained Up to 45 times longer life and up to 90% less downtime for guide changes. Rod produced has better surface finish and more accurate cross-section. Scrap due to cobbles reduced by 85%. Mill yield increased 2% and production costs cut.

Source: *Kennametal, Inc.*



49 Aluminum Drive Arm

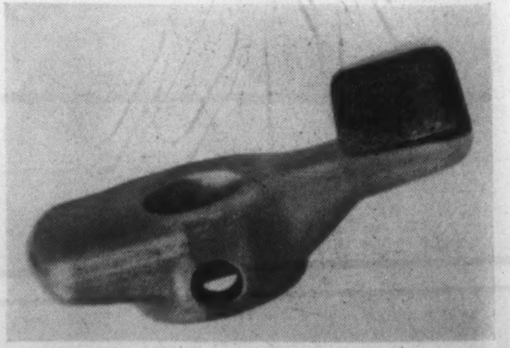
Part used in aircraft engine heater mechanism is about 2 in. long. One side of the fin-shaped end is subjected to severe sliding abrasion. Part must resist this abrasion for a minimum of 1000 hr, yet must also be lightweight.

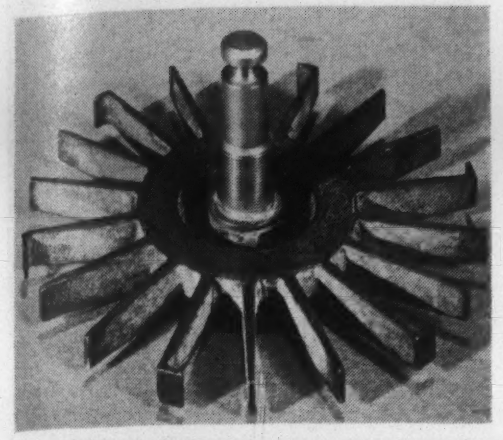
Old Plastic inserts, high alloy precision castings, and high alloy forgings were considered, but high cost or weight made them impractical.

New Wearing surface of forged aluminum part was coated with tungsten carbide (0.002 in. thick) by Flame-Plating process.

Advantages Gained Wear life of forged aluminum part increased from 300 hr to above the required 1000-hr mark while retaining the lightweight quality of aluminum. Tungsten carbide coating was left in the as-coated condition (125 microinches r.m.s.), making unnecessary grinding operations.

Sources: *Signal Electric Corp.; General American Transportation Corp.*





50 Impeller

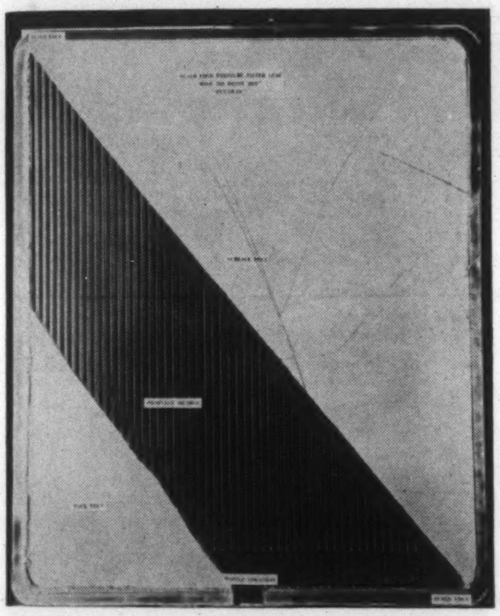
About 2½ in. in dia, impeller must spin in highly accurate flat plane of rotation in order to activate mechanism.

Old Beryllium copper impeller, investment cast around stainless steel hub insert.

New Beryllium copper impeller, investment cast around 4130 steel hub which has a chromium case applied by a previous chromizing process.

Advantages Gained Stainless steel hub of previous form corroded during casting of beryllium copper, resulting in loosened impeller and out-of-plane rotation. Threads had to be rechased and the hub staked. Chromium case prevents corrosion, resulting in accurate operation. Manufacturing costs are reduced due to machinabilty of 4130 hub.

Source: *Bell Aircraft Corp.*



51 Pressure Filter Leaf

Must have uniform pore size and reasonable flow capacity, and must withstand chemical attack.

Old Woven stainless wire cloth in stainless steel frame.

New Fiber-bonded synthetic fiber mats separated by corrugated polystyrene drainage sheet. Mats can be Orlon, Dacron or Dynel, heat-bonded with acetate or vinyl fibers.

Advantages Gained Longer life in certain corrosive environments. Also lower initial cost.

Source: *American Felt Co.*

52 Golf Club Face

Insert for impact surface must be resilient, durable to avoid splintering, and readily machined for precision fitting.

Old Vulcanized fibre.

New Cotton-mat-base high-pressure phenolic laminate. Fabric is unwoven mat consisting of long, random-distributed fibers, thus providing equal strength in two directions.

Advantages Gained Lasts longer because of greater resistance to splintering. Performs better (produces longer drives) because modulus of elasticity approaches that of golf ball. Looks more attractive because insert material is available in various colors.

Sources: *Synthane Corp.; Bailey & Izett*

53 Contoured Valve

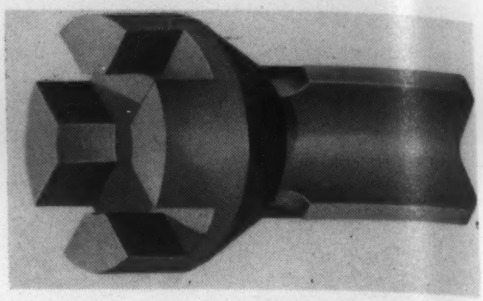
Contoured valves are used in proportioning pumps. They must withstand a variety of corrosive liquids. Alloy chosen depends on ultimate use. Valves should have smooth surface and must have extreme dimensional accuracy at seal contact.

Old Sand cast Monel, Hastalloy C, 440C, 316.

New Investment casting of same alloys.

Advantages Gained Smoother surface attained in investment casting resulted in fewer rejects and improved performance. Porosity and irregularities associated with small sand castings were eliminated. Machining reductions due to improved casting accuracy provided an ancillary cost saving of 53%.

Source: *Microcast Div., Austenal Laboratories*



54 Chemical Warfare Kit Case

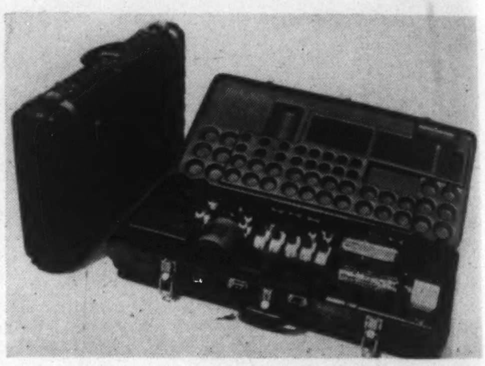
Case for carrying a number of bottles must offer protection and shock resistance. Corrosion resistance in case of spillage is desirable.

Old Metal case with two removable trays.

New Styrene copolymer molding, with floating vacuum-formed liner.

Advantages Gained Size and weight reduced, shock resistance increased due to good damping characteristics of plastic. Ease of forming plastic permitted the liner to be shaped to nest each piece of equipment separately. Color is molded in and eliminates need for painting, or possibility of scratching. Corrosion resistance improved.

Source: *Bassons Industries Corp.*



55 Plating Rolls

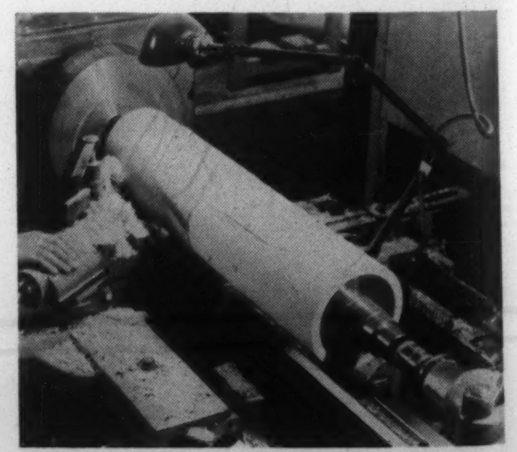
Rolls for plating mills are approximately 45 in. long, with 12-in. o.d. Must withstand attack by chemicals, wear, and abrasion. Must have high mechanical strength combined with good insulating properties.

Old Rubber-covered steel rolls.

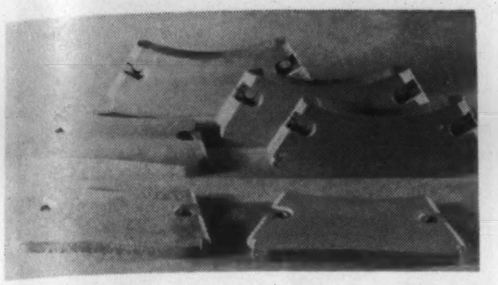
New Continuous-strip laminated plastics wrapped around steel roll and cured by heat.

Advantages Gained Operating life is 3 times greater than that of old rolls. Material is dense, eliminating problem of imbedding foreign particles. Surface toughness eliminates former difficulty experienced when abraded rubber particles would be deposited on strip steel and interfere with electrolytic action.

Source: *Synthane Corp.*



56 Brake Friction Part



Rotating frictional member used in aircraft wheel brake assembly. Must resist distortion resulting from high frictional heat, salt water corrosion, and wear.

Old Plain cast iron.

New Cast iron with chromized case.

Advantages Gained Premature deterioration of surface and freezing up of linkages due to rust was avoided. The greater resistance to wear prolongs rotor life and, most important, preserves protective surface longer than softer coatings.

Source: *Navy Bureau of Aeronautics; Bendix Aviation Corp.; Chromalloy Corp.*

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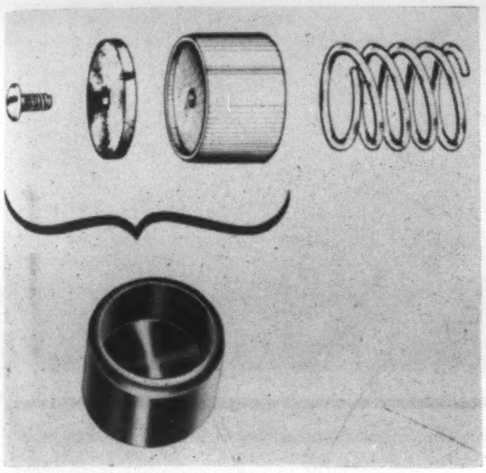
57 Valve Body



Discharge valve body for the piston head of automatic water pump. Must resist abrasion from small particles and be quiet in operation.

Old A three piece assembly consisting of brass machined to retain a washer held in position with a screw.

New A one piece unit of synthetic rubber.

Advantages Gained New rubber part provides much quieter operation, faster installation and is not affected by sand or small particles picked up by the water.

Sources: *International Packing Corp; Lerio Corp.*

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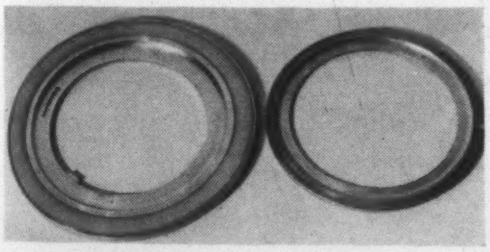
58 Thrust Washer



Used in rotor system of helicopter. Must sustain bearing load of 5000 psi under oscillating motion. Abcut ⅛ in. thick, 3 in. in dia.

Old Phosphor bronze.

New ⅛-in. nylon washer supported by 0.080-in. 4130 steel back-up ring.

Advantages Gained Much longer service life due to elimination of galling resulting from lower coefficient of friction. Possibility of corrosion due to dissimilar metals also eliminated.

Source: *Piasecki Helicopter Corp.*

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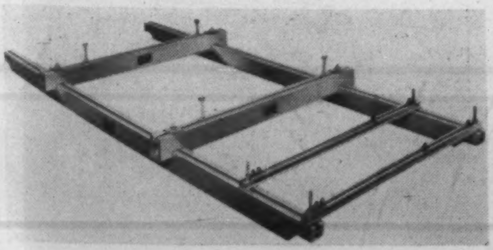
59 Machinery Skid



Used to handle loads up to 10 tons, permitting use of dollies, slings, lift trucks and other materials handling equipment.

Old Wood beams and boards.

New High strength aluminum alloy extrusions cut to length from 3 to 25 ft in 1-ft increments.

Advantages Gained Flexibility of design, easy assembly, 62% lighter in weight, will not warp, no maintenance required.

Source: *Harvey Aluminum*

60 Industrial Filter Holder

Holder for filter papers in industrial plating operations must seal against by-pass leakage, resist corrosion, maintain dimensional tolerances.

Old Stainless steel.

New Machined rigid Polyvinyl chloride.

Advantages Gained Six times the service life of stainless steel in 120 F plating bath consisting of nickel sulphate, nickel chloride, sulphuric acid, and boric acid, having a pH of 2.5. Cost is about equal to stainless steel.

Source: *B. F. Goodrich Chemical Co.*

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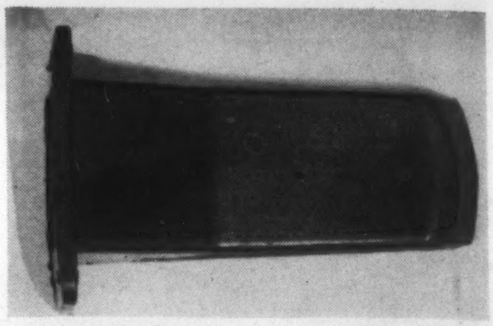
61 Inlet Spout



Inlet spout tubular shape approximately ½ x 2 x 6 in. is inlet for hot and cold water in automatic washer. Must resist water and detergent corrosion.

Old Die cast aluminum.

New Molded rubber, same form.

Advantages Gained Longer life because of increased corrosion resistance.

Source: *The Maytag Co.*

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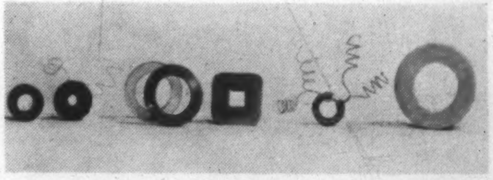
62 Insulating Coating

Insulation for magnetic amplifier cores must be thin, adherent, continuous and heat resistant.



Old Magnesium oxide powder with methyl cellulose binder.

New Anhydrous solution of magnesium methylate which yields a continous magnesium oxide film.

Advantages Gained Cores are smaller with improved magnetic characteristics. The new magnesium oxide films are 1,000 to 10,000 angstroms thick, will withstand temperatures of 2900 F without losing insulation value, so cores can be annealed after coating is applied to laminations. The old insulating material was subject to breakdown at annealing temperatures.

Source: *U. S. Army Signal Corps*

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63 Ordnance Component

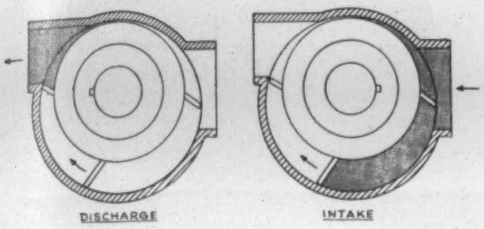
A double diameter tube with connecting web section, 9 in. long, 1¼-in. o.d. is required to withstand 2000-psi gas pressure and be fabricated in quantity to close dimensional tolerances.

Old Three piece assembly—a screw machine part, a sleeve and a plug.

New A one-piece aluminum alloy cold forging, with integral web section.

Advantages Gained Elimination of joints overcame problem of gas leakage; fabrication costs reduced; less metal required; assembly operation eliminated.

Source: *Hunter Douglas Corp.*



64 Supercharger Rotor Vane

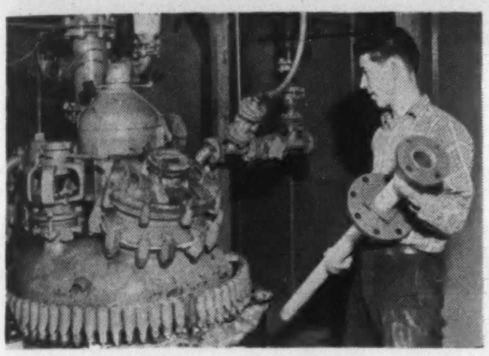
Rotor vane must have high strength, good chemical resistance, good machinability and high dimensional stability even when heated rapidly from subzero temperatures to 200 F. Flat rectangle measures 7¾ x 2¼ x 3/16 in.

Old Bonded graphite.

New Cotton fabric-base high-pressure phenolic laminate.

Advantages Gained Less wear, longer life and greater efficiency resulting from lower starting inertia, greater durability, and ability to hold close tolerances even at operating speeds greater than 8000 rpm.

Sources: *Synthane Corp.; Judson Research & Mfg. Co.*



65 Dip Pipe

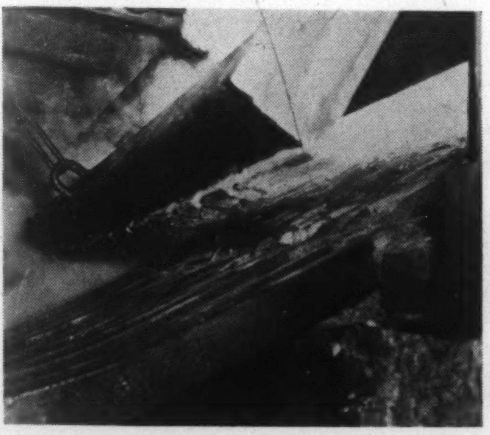
Used on glass-lined reactor processing highly corrosive liquid.

Old Ceramic pipe.

New Pipe laminated from glass fabric and fluorocarbon resin.

Advantages Gained Maximum resistance to mechancial shock, thus eliminating possibility of fracture that might cause costly damage to reactor.

Source: *Resistoflex Corp.*



66 Furnace Discharge Skid Rails

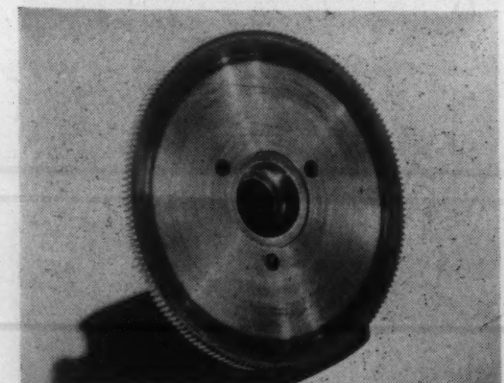
Rails receive hot billets from heat treat furnace, must be wear resistant and withstand ambient temperature of 1800 F in the vicinity of the furnace mouth.

Old Medium manganese steel.

New Cast high alloy (33-37% nickel, 13-17% chromium, 0.35-0.75% carbon, remainder iron).

Advantages Gained Change effected a weight saving of 35%, eliminated water cooling equipment, doubled the life of the installation. The cast alloy can be used satisfactorily in oxidizing atmospheres as high as 2100 F and reducing atmospheres up to 2000 F.

Source: *Ingersoll Steel Div., Borg Warner Corp.*



67 Shutter Gear

Gear has 3-1/2-in. dia. Operates shutter on commercial high speed camera. Must withstand wear operating at 3000 frames per sec (approximately 30 ft per sec) including stop and start.

Old Machined brass.

New Machined 1070 carbon steel with induction hardened teeth.

Advantages Gained Life of gear was increased 15 to 20 times due to increased hardness and wear resistance of teeth. Increased manufacturing cost greatly offset by increase in life.

Source: *Eastman Kodak Co.*

68 Aircraft Engine Cowl

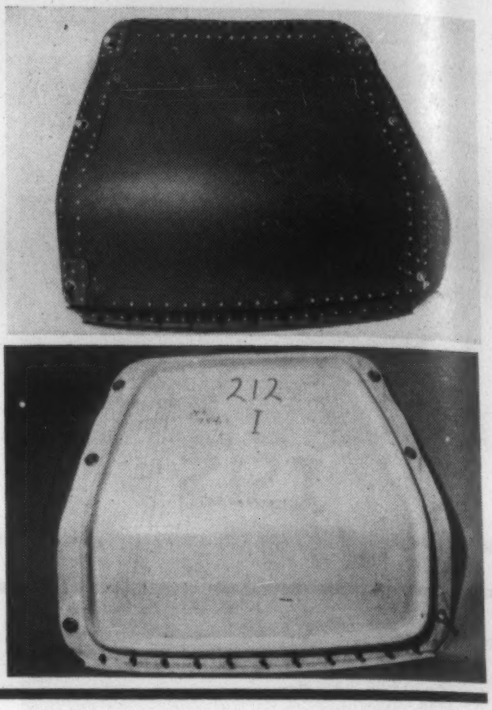
Assembly of seven 19- x 15-in. panels which enclose engine for cylinder head cooling. Must withstand engine vibration and internal air load of about 10 in.

Old Formed aluminum alloy sheet with edge stiffeners.

New Glass-reinforced polyester laminate.

Advantages Gained Longer service life due to superior vibration-dampening properties, better fatigue properties. Also improved corrosion resistance, less deterioration due to mishandling.

Source: *Piasecki Helicopter Corp.*



Top: Old
Bottom: New

69 Instrument Armature

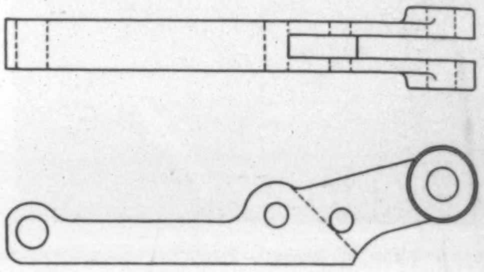
Part used in aircraft instrument. Must have high magnetic pull, corrosion resistance in high-humidity atmosphere.

Old Investment cast ingot iron, chromium plated.

New Investment cast ingot iron with chromized case.

Advantages Gained Improved magnetic pull because of alloy case formation obtained by chromizing which also acts as a magnetic anneal.

Source: *Minneapolis Honeywell Regulator Co.; Chromalloy Corp.*



70 Compressor Valve Poppet

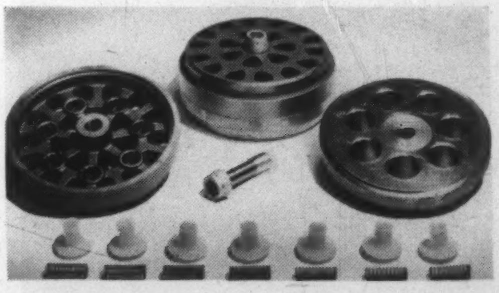
Must withstand high impact accompanying opening and closing of valve, plus exposure to certain acids, oils and hydrocarbons. Size: 1⅜-in. dia. head, ⅝-in. dia. stem, about 1 in. long.

Old Machined from 440-C stainless steel rod.

New Injection molded of nylon.

Advantages Gained Where pressures are less than 1000 psi and temperatures are below 280 F, nylon poppets 1) improve valve efficiency by eliminating inertia forces associated with heavier materials, 2) lengthen coil spring life by reducing valve-opening shock, 3) provide quieter operation by reducing impact on valve body seat and other poppet-enclosure areas.

Sources: *Thompson Products, Inc., E. I. Du Pont de Nemours & Co., Inc.*



71 Flywheel

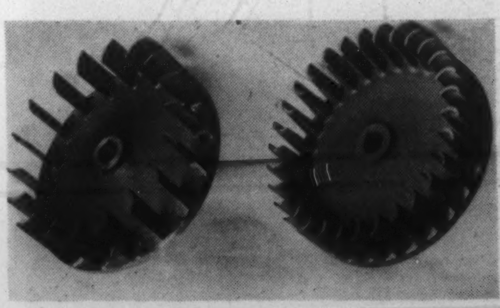
Flywheel for an air cooled engine used in lift truck. Primary function is to cool engine. Must withstand operating stresses and abusive loads.

Old Gray iron casting.

New Weld fabrication of mild steel plate.

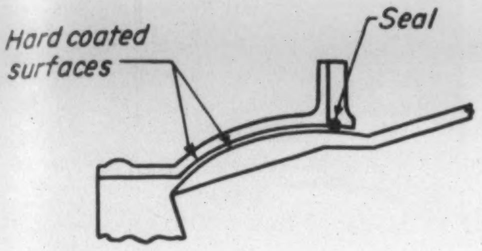
Advantages Gained Reduced weight from 40 to 24 lb; 10% greater cooling capacity; cost of manufacturing reduced 20%. Durability tests have proved steel to be stronger and less susceptible to damage under adverse conditions.

Source: *Lincoln Electric Co.*



New *Old*

72 Flexible Ball Joint



Operates as section of anti-icing duct. Ball ends turn in socket; must maintain seal on air at 45 psi and 450 F during displacement of the axis of the telescoping joint.

Old Balls and collars machined from aluminum alloy bar (24S-T4 balls, 17S-T4 collars).

New Balls and collars machined from aluminum alloy bar (75S-T6) and finished with Martin Hard Coating (an electrolytically-applied oxide coating). Alloy change necessary because 24S and 17S have high copper contents and tend to burn readily in the hard-coating bath. Also, a more abrasion-resistant coating can be obtained on 75S.

Advantages Gained Longer life due to elimination of galling on ball ends. No maintenance required.

Source: *Glenn L. Martin Co.*

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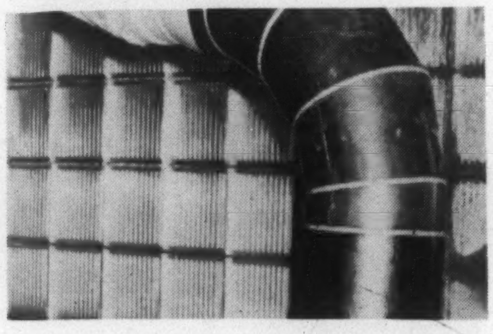
73 Exhaust Ductwork



Ductwork used to exhaust hydrochloric acid vapors.

Old Fabricated by welding sheets of 18:8 stainless steel.

New Fabricated of polyethylene.

Advantages Gained Stainless steel installation lasted 16 months before failure at weld points. Present polyethylene installation has thus far lasted 5 years. Plastics ductwork is 1/5 the weight of previous steel, and costs $490 as compared to $630 for steel installation.

Source: *American Agile Corp.*

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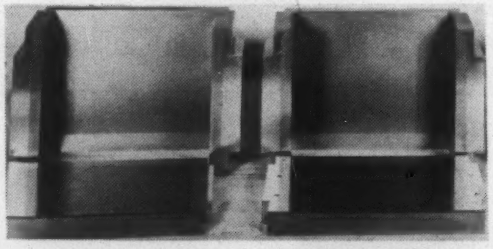
74 Brick-Mold Liners



The abrasive effect of fire brick particles requires an extremely abrasion resistant mold to maintain tolerances.

Old Steel.

New Cemented Carbide (Carboloy 779).

Advantages Gained The old mold liners had to be reground after 13 hr, produced an average of 14,000 bricks between grinds. Regrinding took 3 hr, idled four men. Carbide facings boosted production to 300,000 bricks before regrinding was necessary. Extra benefits include closer tolerances on bricks, which make it possible to adhere to blueprints in furnace construction.

Source: *Carboloy Dept., General Electric Co.*

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75 Coating for Rubber Floor Mats

Floor mats for use in automobiles must resist abrasion, maintain color brilliance.

Old Sprayed rubber coating on black rubber mat.

New Sprayed vinyl latex coating.

Advantages Gained Two years of operational testing revealed that the harder, glossier finish furnished by the vinyl coating provided 40 times the wear and abrasion resistance of rubber. The material is also easier to clean, since it is glossy and does not absorb moisture.

Sources: *Chrysler Corp.; Empire Varnish Corp.; B. F. Goodrich Chemical Co.*

76 Agitator Blades

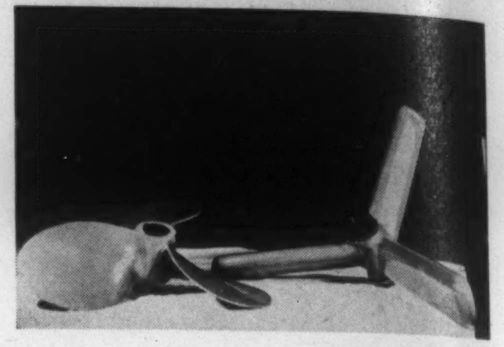
Blades must withstand contact with highly corrosive chemical mixtures without corroding and offer minimum attraction to gummy substances.

Old Stainless steel.

New Stainless steel coated with acid-resisting industrial type porcelain enamel.

Advantages Gained Reduction in both cleaning time and frequency of cleaning due to complete resistance of coating to corrosion and reduced attraction of surface to gummy substances.

Source: *Erie Enameling Co.*



77 Pump Rod Cup

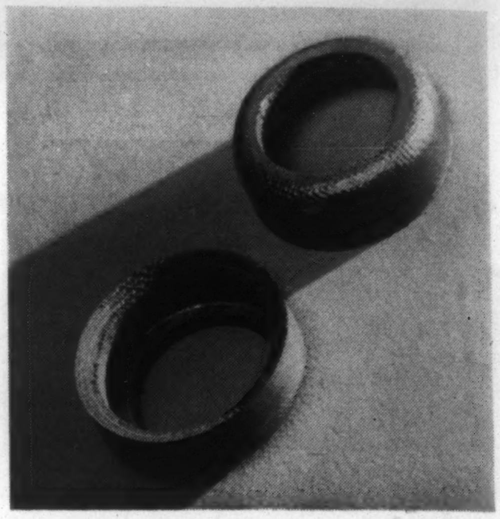
Approximately 2¼ in. in dia by ¾ in. high, cup is used in oil well pump rods and other pumping equipment handling oils and abrasive materials. Must withstand wear, resist abrasion and remain unaffected by oil, water and other materials found in oil wells in order to maintain tight seal in pump barrel.

Old Molded of hard rubber.

New Molded of a synthetic rubber compound made up of Hycar American rubber and two phenolic resins.

Advantages Gained Increased operation of oil well pumps by as much as 3 mo, due to toughness and resistance to grease and solvents.

Source: *Durez Plastics & Chemicals, Inc.; B. F. Goodrich Chemical Co.; Dragon Mfg. Co.*



78 Gear Case

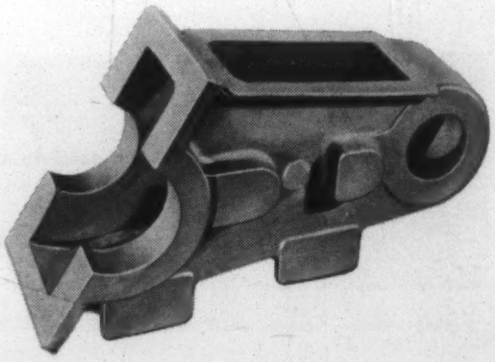
Case used on trolley reduction gear of overhead crane. Rigid alignment required under reversed road conditions.

Old Fabricated of standard rolled steel sections and plate.

New Cast in commercial grade steel.

Advantages Gained An 11% reduction in weight, improved appearance and increased rigidity which resists distortion. Manufacturing cost was reduced 33%.

Source: *Steel Founders' Society of America*



79 Dosimeter Holder

Part holds dosimeter (radioactivity detector) in position for checking degree of radioactivity on dosimeter reader. Part must be light-proof with black, non-reflecting interior.

Old Aluminum die cast assembly.

New Transfer molded phenolic assembly.

Advantages Gained Light-proof door, previously required, eliminated since plastics are molded to eliminate light leakage. Natural black color of phenolics prohibits internal light reflection. Part is lighter in weight with molded-in inserts. Mold costs cut about 50%.

Source: *Durez Plastics & Chemicals, Inc.; Specialty Assembling and Packing Co., Inc.*

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MATERIALS ENGINEERING FILE FACTS

MATERIALS & METHODS • MAY 1955 • NUMBER 298

Wrought Aluminum Alloys in Order of Increasing Hardness

The accompanying table lists the common wrought aluminum alloys and tempers arranged according to their hardness. The clad alloys are not included in this listing for the reason explained below.

Brinell hardness is a measure of the resistance to penetration. This is usually determined for aluminum alloys by impressing a ball 10 millimeters in diameter into the surface of the material with a 500-kilogram load gradually applied.

In Brinell hardness testing of the alclad wrought aluminum alloys, the soft cladding material at the test point is pressed out and away from the 10-mm ball and the hardness of the core material is measured. Therefore, the Brinell hardness of alclad alloys should be approximately equal to the hardness value for the same alloys without cladding and having the same temper designations. For example, alclad 3004-H32 would indicate the same Brinell hardness as 3004-H32, alclad 2024-T36 and 2024-T36 would have the same Brinell hardness, and alclad 7075S-0 would have the same Brinell hardness as 7075S-0.

Alloy and Temper	Brinell Hardness	Alloy and Temper	Brinell Hardness
1100-0	23	5050-H38	63
1100-H12	28	5056-0	65
3003-0	28	6061-T4	65
5005-0	28	6062-T4	65
6061-0	30	6063-T5	65
6062-0	30	5052-H34	67
1100-H14	32	5154-H32	67
5357-0	32	3004-H36	70
3003-H12	35	2117-T4	70
5050-0	35	6063-T831	70
5005-H32	36	5154-H34	73
1100-H16	38	6063-T6	73
3003-H14	40	5052-H36	74
5357-H32	40	3004-H38	77
5005-H34	41	5154-H36	78
6063-T42	42	6063-T83	82
1100-H18	44	5154-H112	83
3004-0	45	5052-H38	85
2014-0	45	2011-T3	95
2017-0	45	2218-T72	95
5050-H32	45	6061-T6	95
5052-0	45	6062-T6	95
5357-H34	45	6063-T832	95
5005-H36	46	2011-T8	100
3003-H16	47	6151-T6	100
2024-0	47	2014-T4	105
5050-H34	50	2017-T4	105
5005-H38	51	5056-H18	105
5357-H36	51	5056-H38	105
3004-H32	52	2025-T6	110
3003-H18	55	2018-T61	120
5050-H36	55	2024-T3	120
5357-H38	55	2024-T4	120
5154-0	58	4032-T6	120
7075-0	60	2024-T36	130
5052-H32	62	2014-T6	135
3004-H34	63	7075-T6	150

NOTE: Brinell Hardness based on 500 kg load, 10-mm ball.

Courtesy Reynolds Metals Co.

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TA-5005(M)

For more information, turn to Reader Service Card, Circle No. 367

MATERIALS ENGINEERING FILE FACTS

MATERIALS & METHODS • MAY 1955 • NUMBER 299

Wrought Aluminum Alloys in Order of Increasing Ultimate Strength

The following table lists the various wrought aluminum alloys and tempers arranged in order of increasing ultimate strength (typical values). For direct comparison in each case, the yield strength is also given.

The difference between ultimate strength and yield strength is the range through which elongation or plastic deformation takes place. Thus the range between ultimate strength and yield strength affords a measure of formability. In other words, of two alloys of approximately the same order of ultimate strength, the one with the lower yield strength will form most readily.

Similarly, of two alloys of approximately the same yield strength, the alloy having the greatest ultimate strength will have better formability characteristics.

Alloy and Temper	Ultimate Strength, Psi	Yield Strength, Psi
EC-O	12,000	4000
1100-O	13,000	5000
1100-H12	15,500	14,000
3003-O	16,000	6000
5005-O	17,000	6000
6062-O	17,000	6500
6061-O	17,000	7000
Alclad 6061-O	18,000	8000
1100-H14	18,000	16,000
5357-O	19,000	7000
3003-H12	19,000	17,000
6951-O	20,000	—
6951-T4 (Air)	20,000	6500
5050-O	20,000	8000
6951-T3	20,000	13,000
5005-H32	20,000	17,000
5005-H12	20,000	19,000
1100-H16	21,000	19,000
6063-T42	22,000	13,000
5357-H32	22,000	19,000
3003-H14	22,000	20,000
5005-H34	23,000	20,000
5005-H14	23,000	22,000
1100-H18	24,000	22,000
5050-H32	24,500	20,500
Alclad 3004-O	25,000	9000
Alclad 2014-O	25,000	10,000
6951-T4 (Water)	25,000	11,000
5357-H34	25,000	22,000
3004-O	26,000	10,000
2017-O	26,000	10,000
Alclad 2024-O	26,000	11,000
3003-H16	26,000	24,000
5005-H36	26,000	24,000
5005-H16	26,000	25,000
2024-O	27,000	11,000
2014-O	27,000	14,000
EC-H19	27,000	24,000
5050-H34	27,500	24,000
5052-O	28,000	13,000
5357-H36	28,000	26,000
6951-T6 (Air)	29,000	18,000
5050-H36	29,000	26,000
3003-H18	29,000	27,000
5005-H18	29,000	28,000
Alclad 3004-H32	30,000	21,000
6063-T5	30,000	25,000
5005-H38	30,000	28,000
3004-H32	31,000	22,000
5050-H38	31,500	29,000
Alclad 7075-O	32,000	14,000
Alclad 6061-T4	32,000	19,000
6063-T831	32,000	29,000
5357-H38	32,000	30,000
7075-O	33,000	15,000
Alclad 6061-T4	33,000	19,000
Alclad 3004-H34	33,000	26,000
5154-O	34,000	15,000
3004-H34	34,000	27,000
5052-H32	34,000	27,000
5154-H112	35,000	16,000
6061-T4	35,000	21,000
6062-T4	35,000	21,000
6063-T6	35,000	30,000
Alclad 3004-H36	36,000	30,000
3004-H36	37,000	31,000
5052-H34	37,000	31,000
Alclad 5055-O	38,000	20,000
Alclad 3004-H38	38,000	33,000
6063-T83	38,000	36,000
Alclad 5055-H111	39,000	24,000
5154-H32	39,000	29,000
6951-T6 (Water)	39,000	34,000
5052-H36	39,000	34,000
3004-H38	40,000	34,000
5052-H38	41,000	36,000
Alclad 6061-T6	41,000	36,000
5056-O	42,000	22,000
5154-H34	42,000	33,000
Alclad 6061-T6	42,000	37,000
2117-T4	43,000	24,000
5154-H36	45,000	36,000
6061-T6	45,000	40,000
6062-T6	45,000	40,000
6063-T832	45,000	40,000
5154-H38	47,000	39,000
Alclad 5055-H34	48,000	36,000
2218-T72	48,000	37,000
6151-T6	48,000	43,000
2218-T71	50,000	40,000
Alclad 5055-H36	52,000	40,000
2218-T61	55,000	40,000
4032-T6	55,000	46,000
2011-T3	55,000	48,000
2025-T6	58,000	37,000
2011-T8	59,000	45,000
5056-H38	60,000	50,000
Alclad 2014-T4	61,000	37,000
2018-T61	61,000	46,000
2014-T4	62,000	40,000
2117-T4	62,000	40,000
Alclad 2014-T3	63,000	40,000
5056-H18	63,000	59,000
Alclad 2024-T4	64,000	42,000
Alclad 2024-T3	64,000	44,000
2618-T61	64,000	54,000
Alclad 2024-T81	65,000	60,000
Alclad 2024-T36	67,000	53,000
2024-T4	68,000	48,000
Alclad 2014-T6	68,000	60,000
2024-T3	70,000	50,000
2014-T6	70,000	60,000
Alclad 2024-T86	70,000	66,000
2024-T36	73,000	57,000
Alclad 7075-T6	76,000	67,000
7075-T6	82,000	72,000

Courtesy Reynolds Metals Co.

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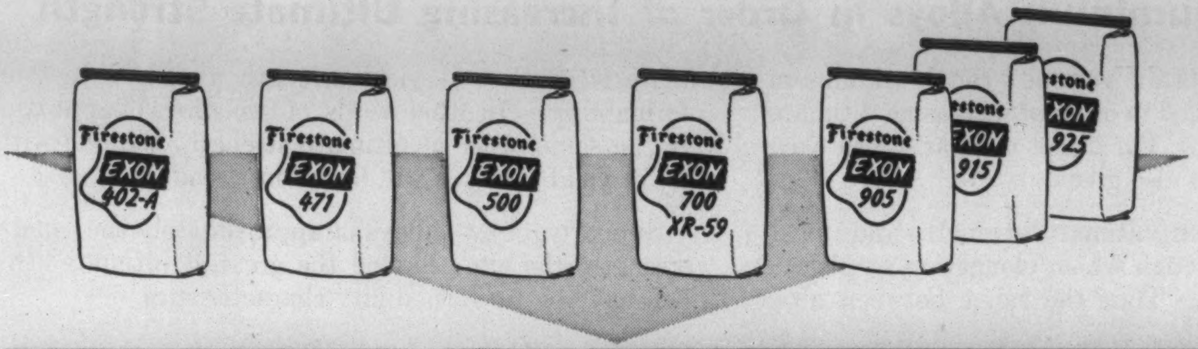
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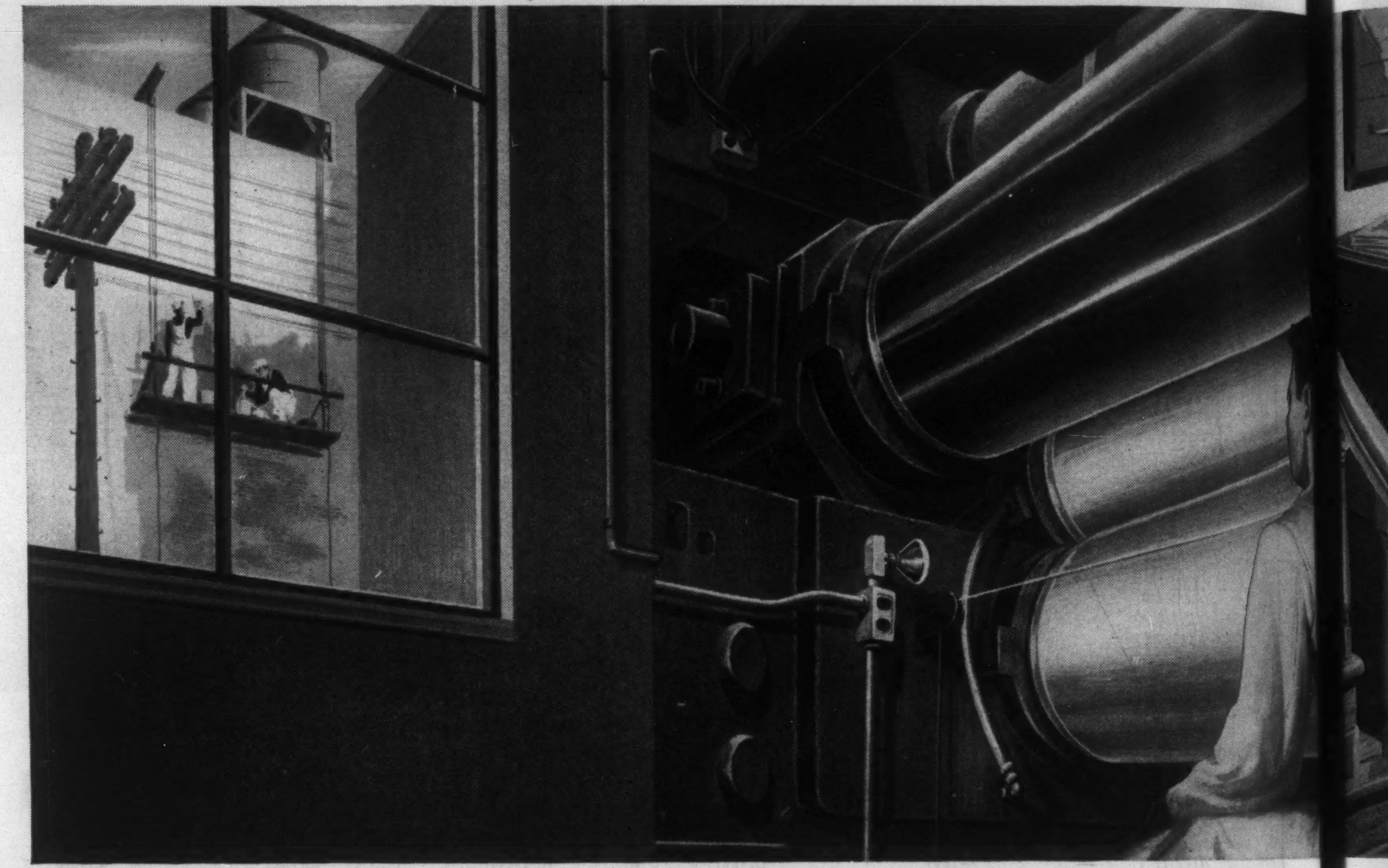

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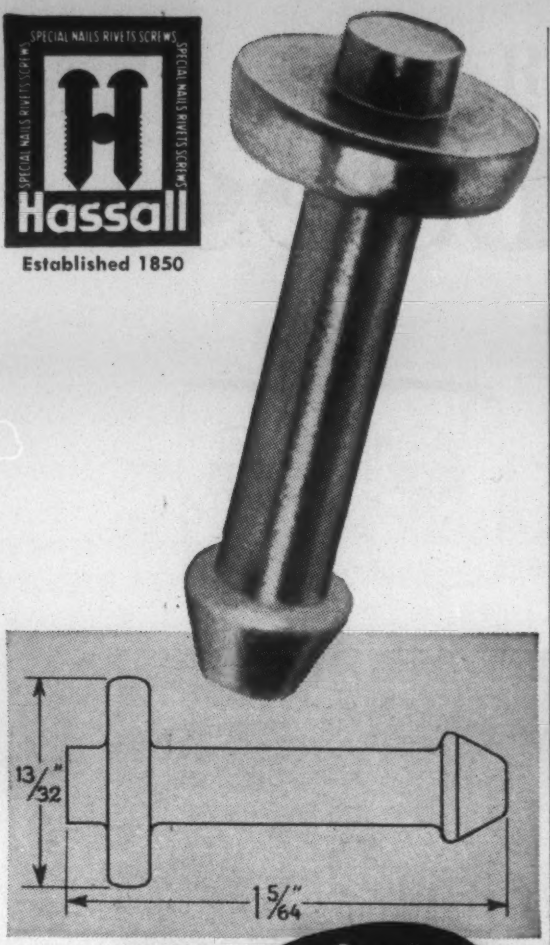

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COLD HEADED	$5.20 per thousand
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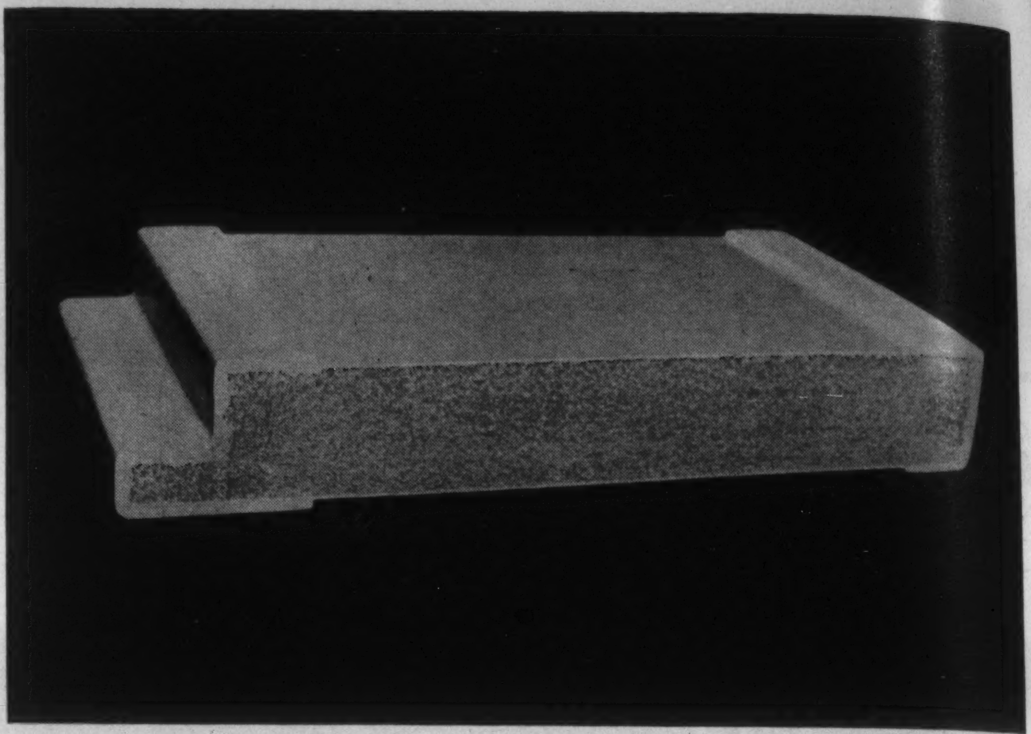


Foamed polystyrene *faced with glass fiber reinforced polyester sheet makes strong and light-weight panels.*

New Low-Cost
Plastics Sandwich Panels

by Kenneth Rose,
Midwestern Editor, Materials & Methods

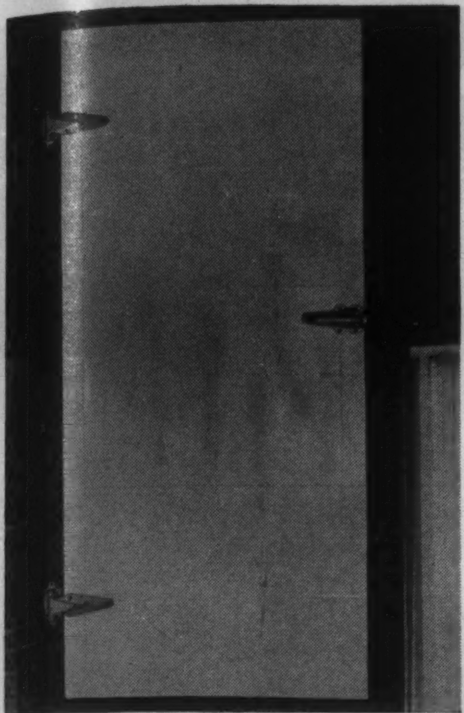
■ While the varieties of sandwich laminates have greately increased and resulting advantages have grown correspondingly, major applications have been relatively few outside the aircraft industry due to the relatively high cost of sandwich materials.

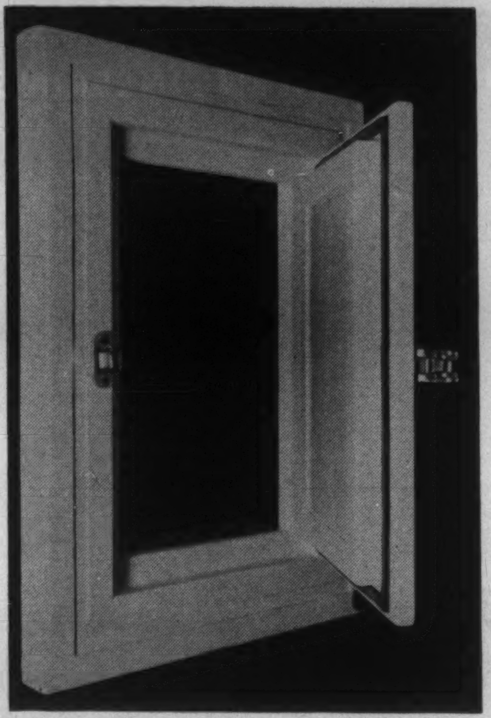
Recently, however, the Haskelite Manufacturing Corp. developed a structural sandwich panel that is reasonably priced and has a wide range of useful properties. While exact price depends upon size, quantity, and thickness of facing and core, in most cases it is comparable with that of conventional insulating boards.

The panel, composed of a foamed polystyrene core faced on both sides with glass fiber reinforced polyester sheet, is strong, light in weight, non-warping, moisture-proof and corrosion resistant, with good fire retarding and thermal insulating properties. Reduction in the cost of the sandwich was accomplished through use of light weight-high strength construction and mass production methods.

The standard panel offered under the trade name Hasko-Struct, is made with polyester-glass faces 0.018 in. or 0.032 in. thick, and with polystyrene core stock (Styrafoam) having a density of 2 lb per cu ft or higher. Standard thicknesses of the sandwich are 1 in., 2 in., 3 in., 4 in., and 6 in., with special sizes running as high as 18 in. Standard width is 48 in. and standard lengths are 96 in., 120 in. and 144 in. Longer or wider pieces are obtained by butt-jointing two sheets with batten strips or special joint fabrications. Two types of adhesives are used in these sandwich panels: one thin in consistency, the other thicker; a quick-setting type with short pot life, and a slow-setting type with a pot life of one day.

As mentioned earlier, the new sandwich material has good strength properties. Some typical values for panels 3 in. thick with 0.030 in. are given below. Maximum bending moment over a 1-in. width is 374 in. lb. Maximum





Good insulating properties *of new sandwich make it useful for refrigerator and cooler doors.*

uniform loads and deflections for 1-in. width are:

Span, in.	*Load, lb.*	*Deflection, in.*
24	748	0.40
48	187	1.61
72	83	3.67
96	47	5.26
120	30	10.2

Suitability of the material for use as insulation is indicated by its low thermal conductivity. Values for standard thicknesses are as follows:

Thickness, in.	*Thermal Conductivity Btu/sq ft/hr/°F*
1	0.24
2	0.12
4	0.06
6	0.04

One problem in fabricating with sandwich construction has been finishing the edges of the sandwich. To permit fabrication with a material similar to that in the original construction, with a minimum of difficulty, Haskelite Corp. produces the polyester-glass fiber laminate in several standard shapes. These include flat strips, angles and channels for door or similar openings. In addition to these standard shapes, other shapes can be made to order in quantity lots.

The adhesive supplied for fabricating the sandwich panels has long shelf life as supplied and can be used up to 12 hr after components are mixed. It has quick tack and develops full strength after aging for 4 to 7 days at room temperature. Retaining stability within normal operating temperatures the adhesive has also proved satisfactory at temperatures to −100 F. In addition to bonding the plastics in the sandwich construction, it has good adhesion to metals, wood and other materials, and requires only ordinary contact pressure. It is a highly moisture-resistant material and is not subject to fungus attack.

In addition to the standard polyester-glass fiber laminates for facing, the sandwich material can be constructed with plywood, special insulation boards, wood fiber board, zinc coated steel, stainless steel, porcelain enameled steel, aluminum or magnesium for one or both faces, or, any of these materials can be used alone or in combination in the core construction.

Present applications of the sandwich material are in insulated transportation, including refrigerated trailers, refrigerated railway cars and insulated shipping containers; coolers and freezing and storage industry applications are also indicated. Possible applications in which light weight alone is important include movable walls and partitions, instrument boxes, pallets and shelters.

Somers

UNIGRAIN®

thin strip brass for deep drawing

Uniform fine grain size of Somers eyelet brass—less than .010 mm. (75X).

with **Fine Grain Finish**

Somers Brass Company is pleased to announce the availability of a new, unique annealing process which makes possible a uniform fine grain of less than .010 mm. which can be drawn to full 40% elongation.

Developed in cooperation with the Selas Corp. of America this new process makes it possible to deep draw Somers THIN STRIP and still obtain a fine grain which is easily buffed to a brilliant finish.

And this new Selas Furnace provides high production as well as close control of temper and uniformity. It is typical of the modern equipment with which Somers produces copper, brass and other alloys to rigid specifications between .010" and .00075".

If you have a problem with thin strip, let Somers experience help you. Write for confidential data blank or field engineer.

FOR EXACTING STANDARDS ONLY

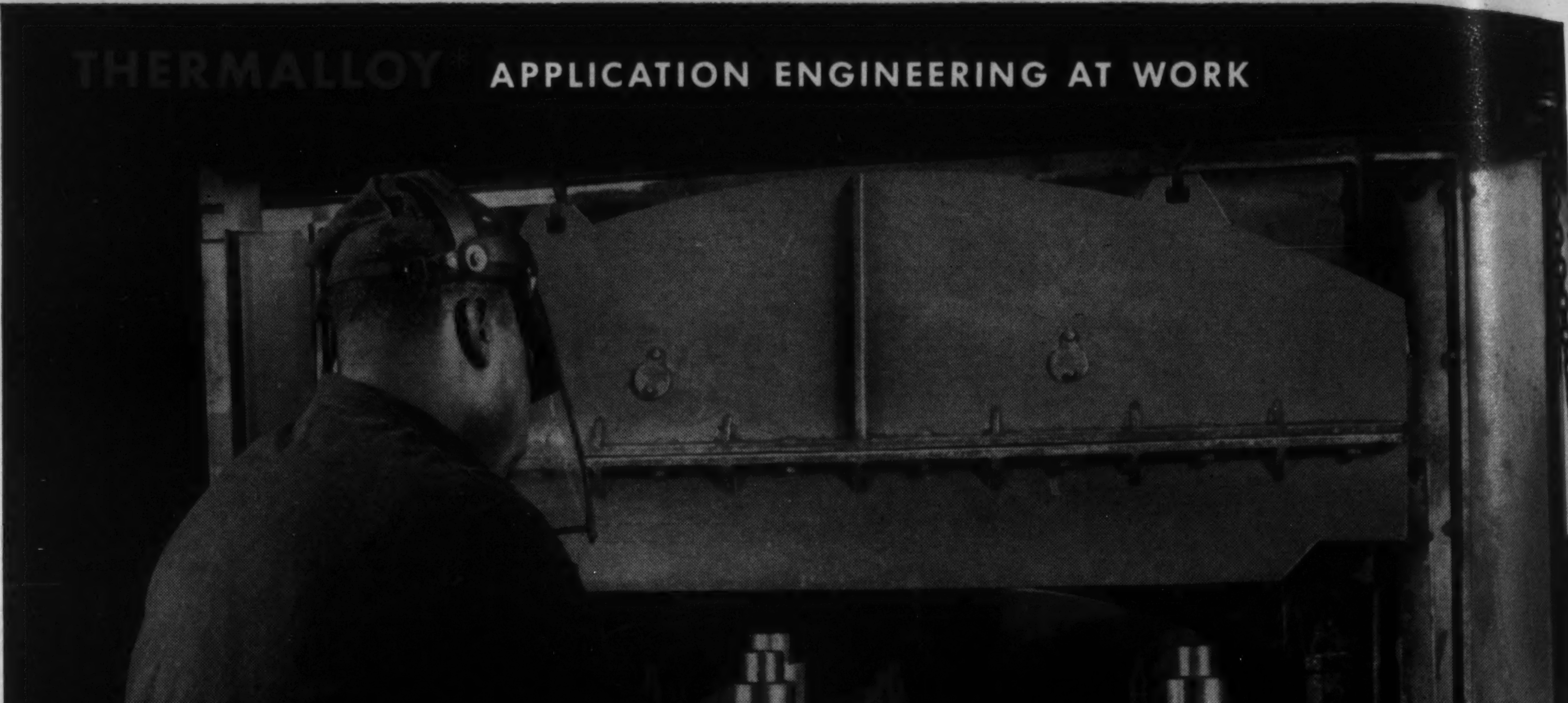
MONEL • NICKEL • COPPER • ALLOYS

THIN STRIP

Somers Brass Company, Inc.
WATERBURY, CONN.

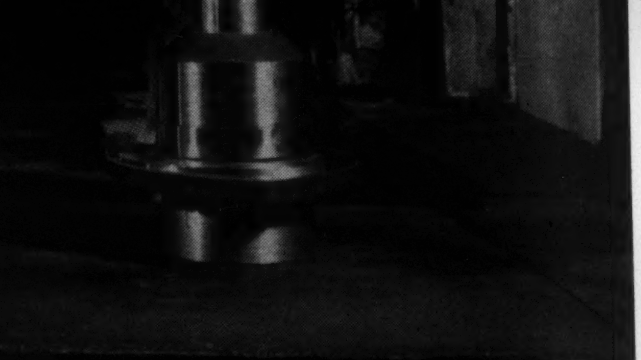
For more information, Circle No. 344

THERMALLOY* APPLICATION ENGINEERING AT WORK



specify THERMALLOY FURNACE CONVEYOR BELTS

for heavier loads at high heat



This partially assembled belt section shows the short integral cast pins that eliminate "crank shafting" in Thermalloy heavy-duty conveyor belt installations.

55″ wide on bearing centers of 32′, this new furnace conveyor belt at Commonwealth Industries, Inc., Detroit, carries over 35 lbs. per sq. ft. in normal service. At times, a total of 5,000 lbs. and more is loaded on the belt. And it's versatile! Work ranges from ½ lb. to 100 lbs. per piece, temperatures up to 1650°.

Here was the problem. Commonwealth, modern commercial heat-treater for the automotive industry, needed a belt which could carry small and large parts to be heat-treated, in volume. They asked Electro-Alloys to help. Starting with the Thermalloy heavy-duty belt design, Electro-Alloys engineers designed special side links to keep the small work from rolling off into the furnace bed. The results have been higher production at less cost for Commonwealth, and another successful case history of Thermalloy application engineering at work.

Our permanent staff of engineers is ready to help *you* design, improve or modernize the alloy in your heat-treating installations. Thermalloy heat-resistant alloys are cast for many furnace and other heat-treat applications. Write us in Elyria, Ohio, for Conveyor Belt Bulletin T-241, or call any of the sales offices listed below.

*Reg. U. S. Pat. Off.

AMERICAN **Brake Shoe** COMPANY

ELECTRO-ALLOYS DIVISION
6001 TAYLOR ST., ELYRIA, OHIO
Sales offices in: Los Angeles, Oakland, Chicago, Detroit, New York,
Cleveland, Toledo, Philadelphia, Pittsburgh

For more information, turn to Reader Service Card, Circle No. 451

New Materials, Parts and Finishes | and related equipment

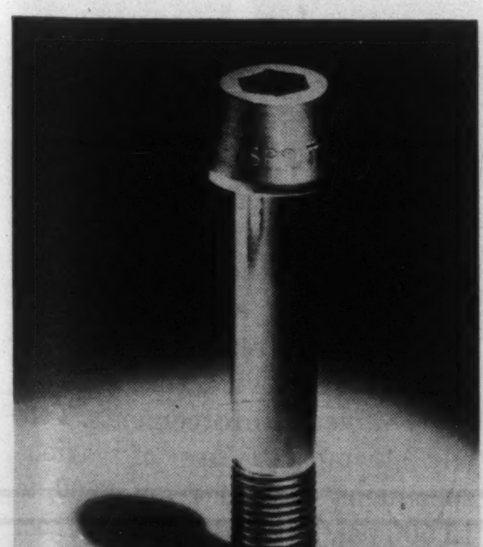
Titanium Bolts Cut Fastener Weight

Weighing only about 57% as much as steel, titanium has been of critical interest to the aircraft and other industries where weight is at a premium.

Titanium tension bolts are now being produced in commercial quantity by *Standard Pressed Steel Co.*, Jenkintown, Pa. Though the majority of production has been in ½-in. dia, 2¾-in. long internal wrenching bolts, the company is said to be producing other types and sizes. Called Hi-Ti bolts, they are designed as direct replacement for Military Standard 20004-series bolts being used in critical fastening jobs in airframes and engines. Price for the ½-in. dia bolts is reported to be somewhere under $100 per lb.

The Hi-Ti bolts are fabricated from a 4 aluminum-4% magnesium titanium alloy. Weight of titanium is about 57% that of steel, thus 1 lb of titanium bolts can do the job of 1¾ lb of steel bolts. Typical mechanical properties of SPS Hi-Ti bolts are indicated in an accompanying table in comparison with properties of steel bolts.

(More New Materials on page 154)



***Majority of SPS production** has been concentrated on this ½-in. dia, 2-in. long internal wrenching bolt.*

MECHANICAL PROPERTIES OF HI-TI AND STEEL BOLTS (MS20008 TYPE)

	SPS M.S. Steel (AMS6322)	SPS Hi-Ti Titanium (4A1—4Mn)
Tensile strength, psi		
Root Thread Area	200,000	171,000
Mean Thread Area	187,500	159,000
Pitch Thread Area	174,000	147,850
0.357 Gage Specimen	174,500	169,000
Yield Strength, psi		
Root Thread Area	183,500	162,000
Mean Thread Area	171,000	150,500
Pitch Thread Area	159,000	140,000
0.357 Gage Specimen	162,000	153,000
Elongation, %		
0.357 Gage Specimen	15.6	16.9
Reduction in area, %		
0.357 Gage Specimen	56.6	36.5
Shear Strength, psi		
Bolt Body	110,000	103,750
Endurance limit, psi		
10% Preload	40,000	50,000
Strength-Weight Ratio*		
Ultimate strength	174,500	295,750
Endurance limit	40,000	87,500

** Using density of steel as unity—Density of steel = 0.28 lb/cu in. and titanium = 0.16 lb/cu in.*

New Materials, Parts and Finishes

and related equipment

Vinyl Coating Improves Fire Resistance

Intumescent coatings, which swell when exposed to heat, tend to prevent early combustion of materials to which they are applied, or tend to snuff out the fire if the surface has already been ignited. Unfortunately, most coatings with intumescent properties have been brittle, short-lived, and complicated to prepare.

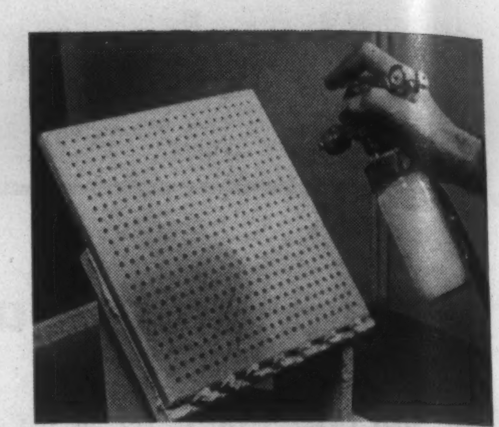
A new type of intumescent coating, based on a vinyl latex, is said to be tough, flexible, resistant to scrubbing and moisture and to possess a good finish. It can be made up without difficult mixing procedures and produces good intumescence when exposed to heat. The vinyl latex is designated Dow Latex 744-B by the manufacturers, *Dow Chemical Co.*, Midland, Mich. The coating can be applied by roller or spray. Spray coatings are smooth and easily controlled as to thickness, while roll coating generally requires less equipment maintenance.

Formulation

Coatings are prepared by mixing monoammonium phosphate, dicyandiamide, pentaerythritol and a suitable pigment with water, dispersing the mixture and stirring-in the latex. Proportions may be varied from about 15% latex upwards, depending on moisture resistance and toughness desired. A typical formulation might be as follows:

	Parts by Weight
Monoammonium phosphate	56
Dicyandiamide	10
Pentaerythritol	22
Titanium dioxide	12
Dow Latex 744-B (50% solids)	50
Water	33
Total solids	68.5%
Latex binder solids	20.0%

After mixing, the coating may be applied at once or stored for several days. After application the film should be heated to about 300 F for several minutes. High-temperature drying and fusion in gas-fired, forced-air ovens is recommended. Where facilities are not available, coating formulations may be modified to permit fusion at about 200 to 250 F for 3 to 4 min. A wide range of fire retardant and moisture resistant properties can be obtained by varying proportions of the three chemical ingredients and the latex binder.



New coatings *may be sprayed or rolled to provide good finish.*

In addition to use as a coating for combustible wallboard and acoustical tile, it is said to be suitable for imparting fire resistance to combustible board insulation and vibration cushioning materials.

Low-Pressure Phenolic Laminating Resin

A phenolic laminating resin which can be used with glass cloth to produce reinforced products by either contact or vacuum bag methods has been marketed by the *Marblette Corp.*, 37-21 Thirtieth St., Long Island City 1, N.Y. Use of glass cloth reinforcing improves the impact strength and toughness of phenolic resins. High pressure phenolic-glass laminates have found wide use in industry; however, at contact pressures it has been impractical to produce phenolic laminates with good bonds between the resin and the glass.

In addition to higher impact strength and toughness, reinforcing the phenolic resin with glass provides the following features: 1) higher tensile strength and stiffness; 2) improved dimensional stability; 3) reduced warpage; 4) increased resistance to chipping and abrasion; and 5) heat distortion point of 300 F.

Designated Phenolic Laminating Resin #1053, the material provides flexibility in fabrication of plastics tools, since it can be formed either by hand-lay up method or by casting a tool with a glass reinforced surface.

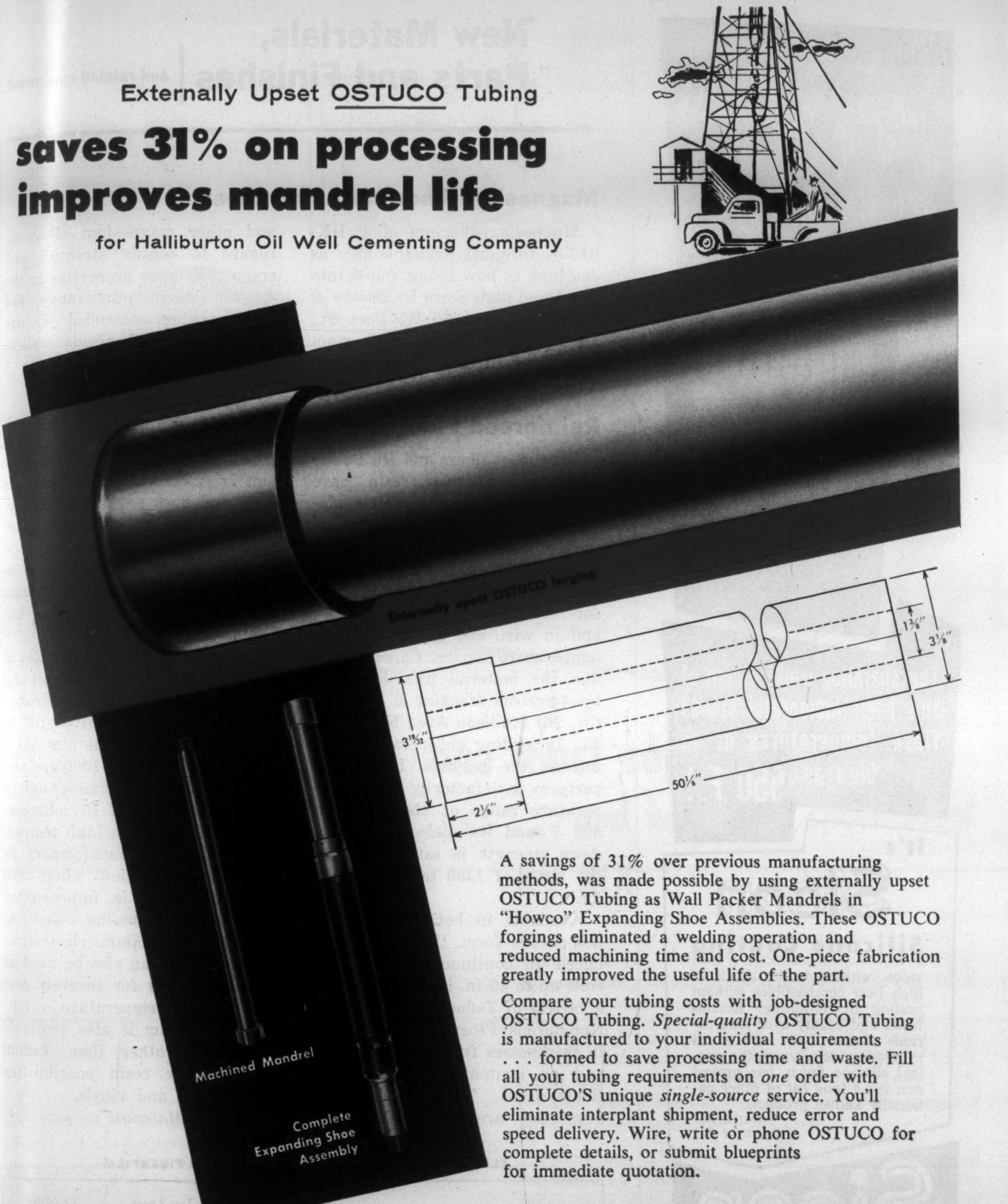
Physical tests were carried out on laminates consisting of resin #1053 and various types of glass cloth and mat. It was found that adhesion between glass and resin is largely dependent upon the structure of the fibrous glass. Random mats and open weave cloths furnish results superior to close weave construction or thick, dense woven reinforcements. Tensile strength values of various specimens ranged from 2500 to 12,500 psi, flexural strength from 9000 to 12,500 and compressive strength from 4500 to 9500 psi. Izod impact strength ranged from 3.2 to 13.1 ft-lb per in. of notch.

(More New Materials on page 156)

Externally Upset OSTUCO Tubing

saves 31% on processing improves mandrel life

for Halliburton Oil Well Cementing Company


Externally upset OSTUCO forging
1⅜"
3⅛"
3 19/32"
2⅛"
50⅛"
Machined Mandrel
Complete Expanding Shoe Assembly

A savings of 31% over previous manufacturing methods, was made possible by using externally upset OSTUCO Tubing as Wall Packer Mandrels in "Howco" Expanding Shoe Assemblies. These OSTUCO forgings eliminated a welding operation and reduced machining time and cost. One-piece fabrication greatly improved the useful life of the part.

Compare your tubing costs with job-designed OSTUCO Tubing. *Special-quality* OSTUCO Tubing is manufactured to your individual requirements . . . formed to save processing time and waste. Fill all your tubing requirements on *one* order with OSTUCO'S unique *single-source* service. You'll eliminate interplant shipment, reduce error and speed delivery. Wire, write or phone OSTUCO for complete details, or submit blueprints for immediate quotation.

OSTUCO SHELBY, OHIO

OSTUCO TUBING

SEAMLESS AND ELECTRIC WELDED STEEL TUBING
—*Fabricating and Forging*

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CANADA, RAILWAY & POWER ENGR. CORP., LTD.
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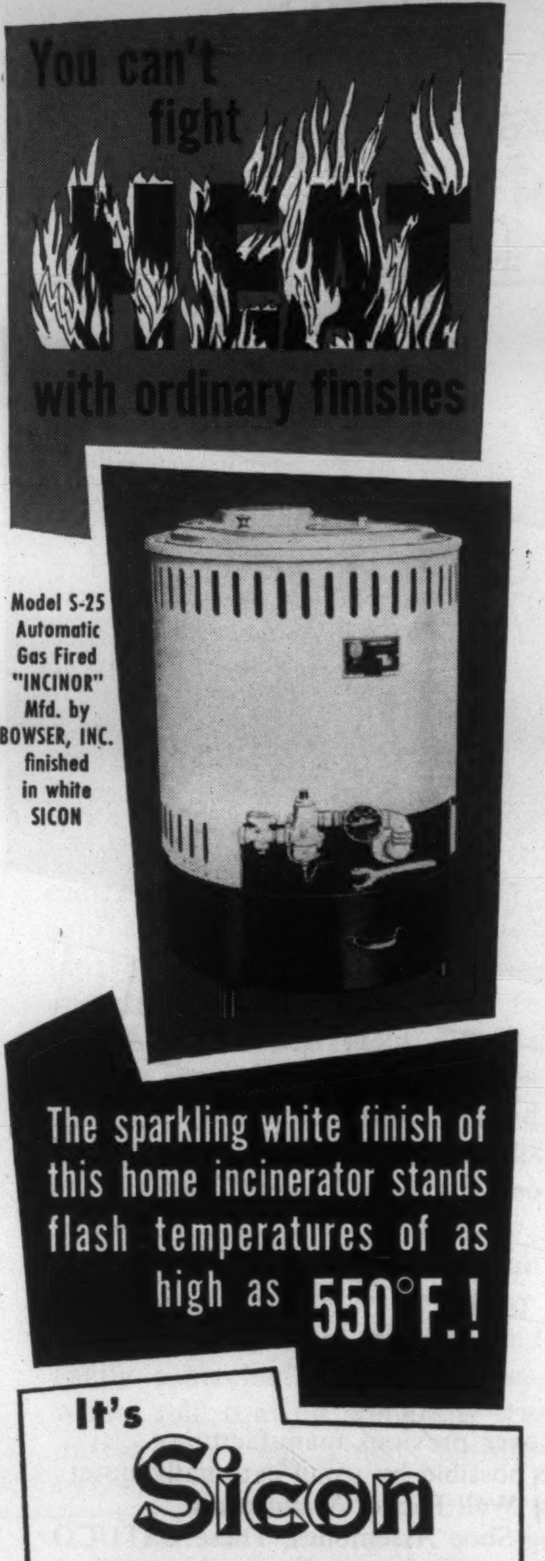
For more information, turn to Reader Service Card, Circle No. 340



Model S-25 Automatic Gas Fired "INCINOR" Mfd. by BOWSER, INC. finished in white SICON

The sparkling white finish of this home incinerator stands flash temperatures of as high as 550°F.!

It's Sicon Silicone Coating

SICON withstands the shock of high heat combustibles without peeling or blistering. Retains luster and beauty over long periods of time. Now used on all INCINOR models. SICON, the original silicone finish, has proved *best* for a long list of other nationally known products.

WRITE FOR BULLETIN 531

Sicon

Silicone-Base Finish is manufactured exclusively by

MIDLAND Industrial Finishes Co.
Waukegan, Illinois
ENAMELS · SYNTHETICS
LACQUERS · VARNISHES

For more information, Circle No. 434

New Materials, Parts and Finishes

and related equipment

Magnesium-Thorium Alloy Sheet

Magnesium-thorium alloy HK-31XA, formerly available only as castings is now being rolled into sheet and plate form by *Brooks & Perkins, Inc.*, 1950 W. Fort St., Detroit 16. Magnesium-thorium alloys are superior to aluminum and other magnesium alloys in regard to tensile strength and creep resistance properties in the 300-700 F temperature range. The alloys are recommended for use in jet engine and missile applications.

Reinforced Fluorocarbon Insulation

Fine glass fibers and Du Pont's Teflon fluorocarbon resin have been combined in a new insulating material. It is said to be particularly well suited for use in high temperature low-loss capacitors of both dry and wet type, for interlayer insulation in coils, and in wire and cables for high temperature service. Called Fiberfilm the material was developed by *American Machine & Foundry Co.*, 261 Madison Ave., New York 16. Depending on operating conditions, the material is said to perform satisfactorily at a temperature range of about 400 to 500 F and its dielectric breakdown strength is satisfactory in the range of 1400 to 4000 v/mil, d.c.

Available in both porous and non-porous form, the film is produced in continuous lengths or rolls up to 40 in. in width, and in a variety of Teflon-to-glass ratios. Non-porous Fiberfilm can be made in thicknesses from 0.8 to 1.7 mil and as laminations of varying thicknesses. Typical electrical properties are indicated in an accompanying table. Non-porous film is stiffer than other plastics films and does not stretch appreciably up to the breaking point, permitting easier handling on winding machines. According to the company, incidence of low-dielectric-strength-areas in the film is small.

Porous Fiberfilm is available in thicknesses from 0.6 to 13 mil and maximum pore size is controlled at any porosity level from 100 to 5 microns. The porous film has a dissipation factor at 1000 cps and 75 F of 0.002 maximum and a volume resistivity of 10^{15} ohm-cm. It is finding uses in high temperature coils and transformers as interlayer insulation where the entire assembly is impregnated with silicone resins, and as spacers in tantalum electrolytic capacitors. It can also be used as a filter medium for severely corrosive high temperature conditions. Fiberfilm is also available with resins other than Teflon. Among other resin possibilities are silicones and vinyls.

(More New Materials on page 158)

ELECTRICAL PROPERTIES OF NON-POROUS FIBERFILM

	Standard Film	Two-Layer Laminated Film	Specially Treated Film
Dielectric breakdown, v, d.c.	1750	5900	4800
Thickness, mils	1.2	2.4	1.2
Dissipation factor, at 1 kc	less than 0.001	less than 0.001	less than 0.001
Volume Resistivity, at 25 C, ohm-cm	10^{16}	10^{16}	10^{17}
Dielectric constant, at 25 C and 1 kc	2.1	2.1	2.1

one must set the example

. . . and with high speed steel it's REX

It's a real satisfaction when you set the example by what you make . . . when it becomes a *standard for comparison*. That's why Crucible is proud to have kept REX high speed steel tops in its class for so many years.

But don't take our word for REX's superiority. Try it on your own work. Compare its structure, finish, hardenability, carbide distribution and general uniformity. You'll see for yourself why it's the *standard* wherever high speed steels are used.

Remember, REX is made only by Crucible. So call for REX at your nearby Crucible warehouse, or for quick mill delivery – *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

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NICKELOID METALS

look good from any angle

Whether you're angling for a new product design, re-designing an established product, or casting for fresh design ideas for a functional part or decorative trim . . . take a good look at Nickeloid pre-plated Metals. Reflected in their gleaming, durable finishes of chrome, nickel, copper and brass you will find a whole new realm of exciting design possibilities. You will find, too, many design success stories which resulted when Nickeloid Metals were considered in the *pre*-design stage, to take *full* advantage of their versatility and their lower production cost.

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Free Booklet — 24 pages of illustrations and data covering properties, uses and fabrication techniques for Nickeloid Metals. Get yours today!

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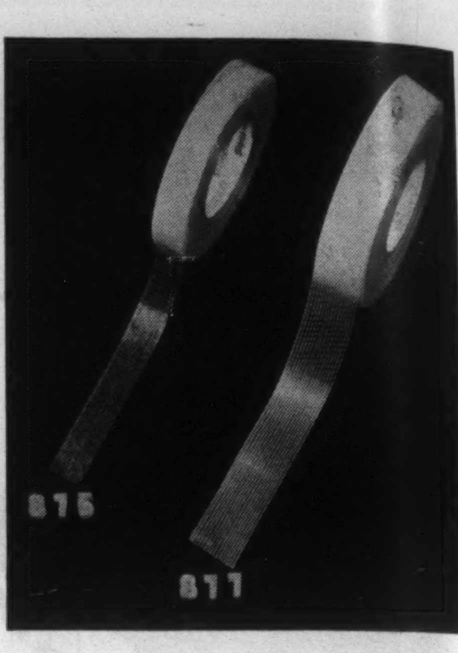
New Materials, Parts, Finishes



Glass Fibers Reinforce Polyethylene Tape

Two glass reinforced polyethylene tapes, pressure-sensitive "Scotch" brand No. 875, and non-pressure-sensitive "Scotch" brand No. 877, are being manufactured by *Minnesota Mining and Manufacturing Co.*, Dept. P-536, 900 Fauquier St., St. Paul, Minn.

With filaments sandwiched between polyethylene backing and pressure-sensitive adhesive No. 875 has a tensile strength of 150 lb per in. of tape width, and a thickness of 9 mils. The adhesive is said to grip immediately on contact. The other tape, No. 877, has filaments sandwiched between two layers of polyethylene, producing a tensile strength of 100 lb per in. of tape width, with a thickness of 11½ mils. Heat-sealable, No. 877 is activated by temperatures of 275 to 600 F, and adheres within 10 to 30 sec under normal hand pressure, the company says. The backings of both tapes, according to 3M, are resistant to most chemicals with the exception of hot xylene, and their low temperature characteristic permits them to remain flexible at −60 F.

Though originally developed and used to reinforce the plastics panels of weather balloons, other applications recommended by the manufacturer are as edge rein-

if

●YOU PLATE METAL

●YOU PAINT METAL

●YOU WELD ALUMINUM

●YOU STRIP ORGANIC FINISHES

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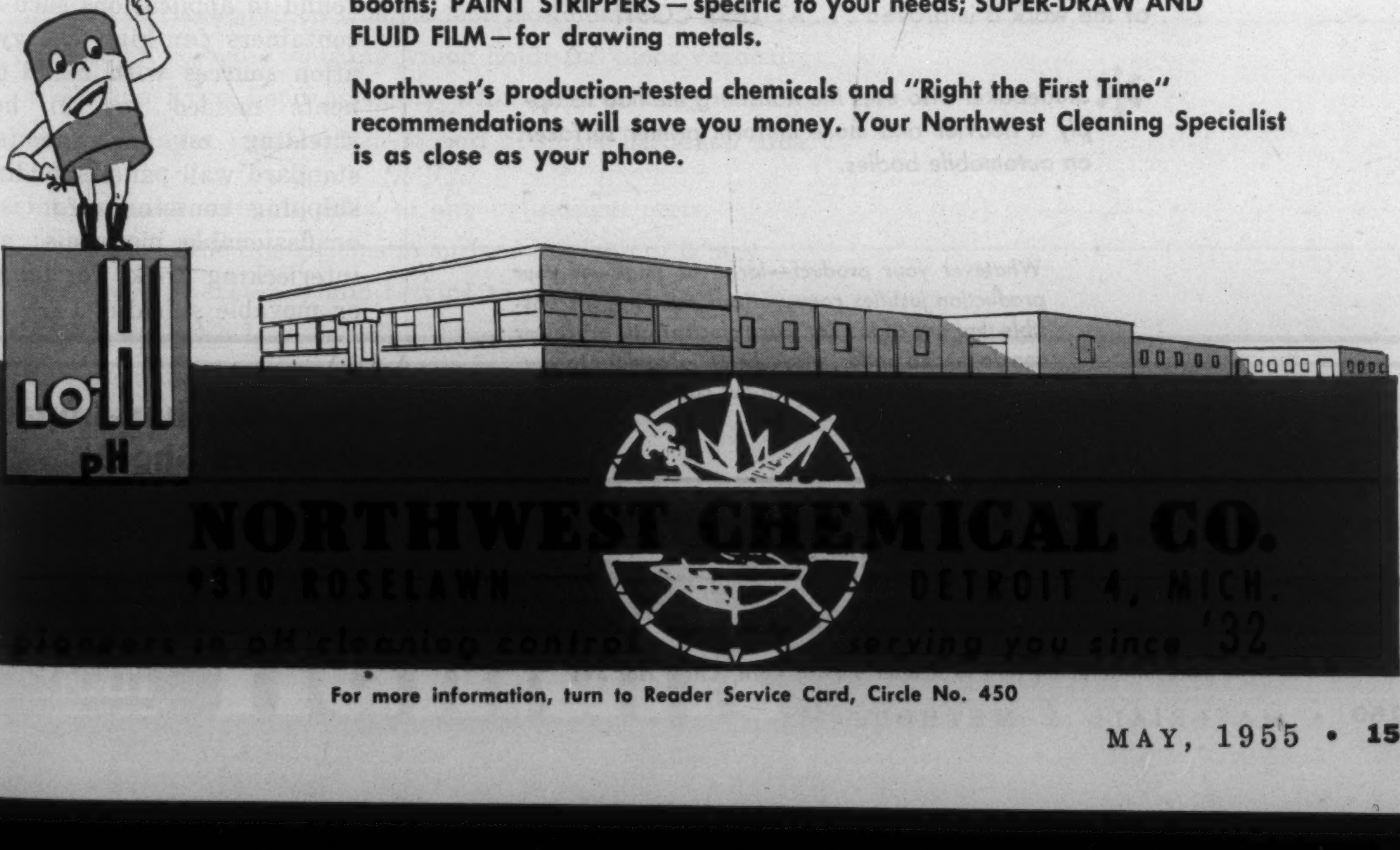
Northwest's years of research in formulating and perfecting analytically correct, job-adjusted cleaners are your assurance of the right chemical for your job.

Northwest's Metal Cleaning Specialists have at their command such outstanding processes as LO HI pH—for cleaning prior to plating, painting or vitreous enameling; ALKALUME—for preparing aluminum for finishing and spot welding; INTERLOX—for phosphate coating; SPRA-LUBE—to control overspray of "todays" paints in water-wash paint booths; PAINT STRIPPERS—specific to your needs; SUPER-DRAW AND FLUID FILM—for drawing metals.

Northwest's production-tested chemicals and "Right the First Time" recommendations will save you money. Your Northwest Cleaning Specialist is as close as your phone.

Remember—YOUR COST PER FINISHED ARTICLE IS THE TRUE COST OF YOUR CLEANER



NORTHWEST CHEMICAL CO.

9310 ROSELAWN DETROIT 4, MICH.

pioneers in pH cleaning control serving you since '32

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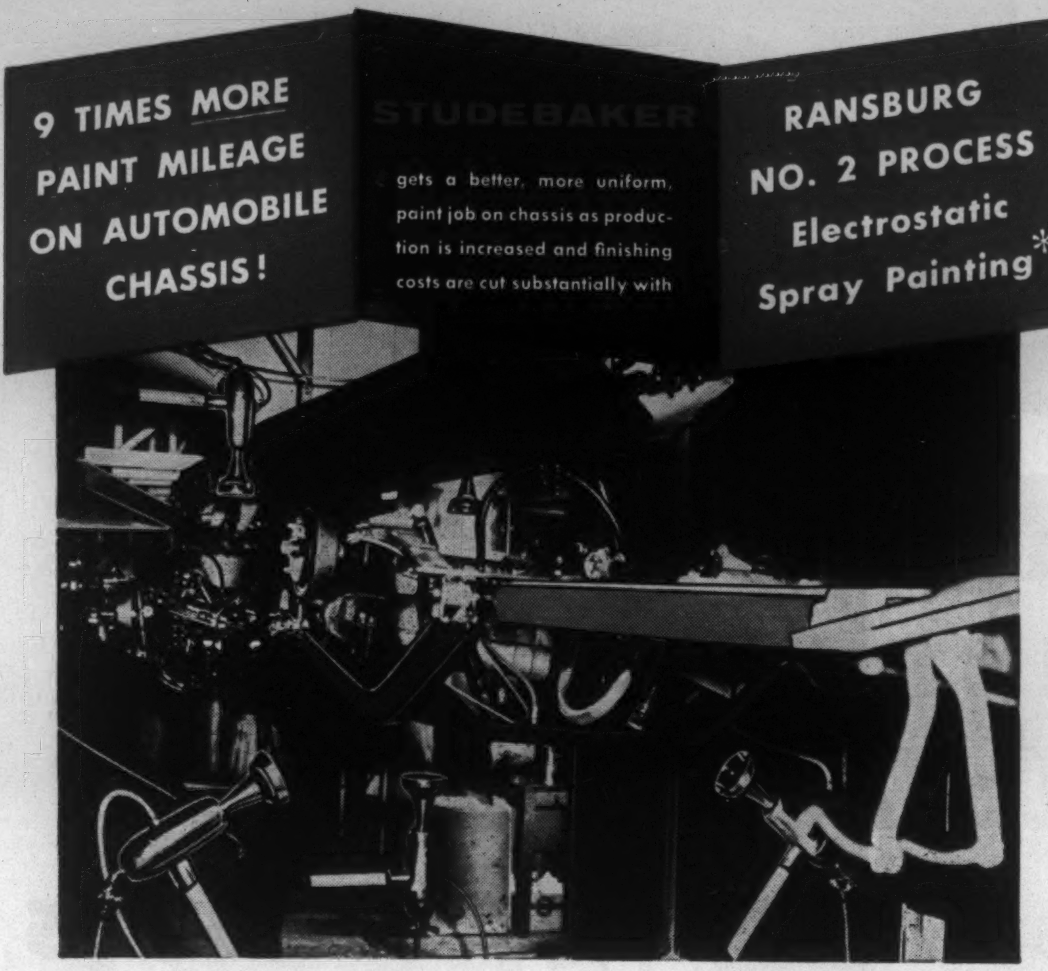

9 TIMES MORE PAINT MILEAGE ON AUTOMOBILE CHASSIS!
STUDEBAKER
gets a better, more uniform, paint job on chassis as production is increased and finishing costs are cut substantially with
RANSBURG NO. 2 PROCESS Electrostatic Spray Painting*

● When Studebaker Division, Studebaker-Packard Corporation switched to Ransburg No. 2 Process of Electrostatic Spray painting on their automobile chassis, paint mileage was increased 9 times.

By simply putting the paint where it's supposed to go, Studebaker cut daily paint consumption on the chassis production line from 14½ drums to 1½ drums. And, still they are painting 6 more chassis per hour with the No. 2 Process.

In addition to getting better, more uniform coverage with the asphalt-type coating, paint and labor costs were cut 70¢ per chassis. In eliminating the former set-up with 2 water wash booths and 12 automatic spray guns, they save nearly 1000 square feet of badly needed floor space.

Another on-the-job-example of the unmatched efficiency of the Ransburg No. 2 Process in which quality of the work is improved . . . AT LESS COST!

* *Studebaker also uses the Ransburg method to apply a heavier and more uniform primer surfacer on automobile bodies.*

Whatever your product—large or small—if your production justifies conveyorized painting, it's possible that one of the Ransburg electrostatic processes can do the job better, with substantial savings to you. We'll be glad to tell you about complete Ransburg services.

Write to Dept. M.

Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

For more information, turn to Reader Service Card, Circle No. 391

forcement in the woven wire and silk screen industry, and for strengthening lightweight plastics tarpaulins in the construction industry. Available in standard rolls of 72 in., No. 875 tape varies in width from ¼ to 21 in., and No. 877 from ¼ to 34 in. Longer rolls can be made on special order.

Lead-Plastics Compound Cuts Radiation

A new lead-plastics compound containing 95% lead has been developed for various types of radiation shielding applications. The material, called Leadcast, is said to be harder and to possess greater structural rigidity than lead, yet at the same time to be capable of being molded accurately. Inserts may be molded-in with good bond strength. According to the company, *Telectro Industries Corp.*, 35-18 37th St., Long Island City, N. Y., dimensions on any shape can be held to tolerances of ± 0.0005 in. As-molded surfaces require no finishing and are inert to oxidation and other corrosive contamination.

The lead-plastics ratio may be varied, controlling hardness from that of a rubbery-like material to that of cast aluminum. Uses for the material are expected to be found in applications such as: 1) containers for high energy radiation sources with metal components molded in; 2) housing shielding on instruments; 3) standard wall panel shielding; 4) shipping containers for isotopes or fissionable materials; and 5) interlocking bricks for temporary or movable shielding.

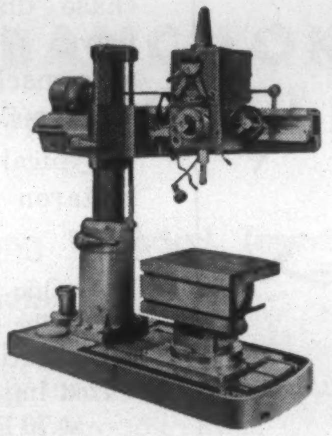
New Medium-Impact Plastics Sheet

A new low-cost thermoplastic sheet material with an Izod impact strength of about 6 ft-lb per in. of notch has been marketed as

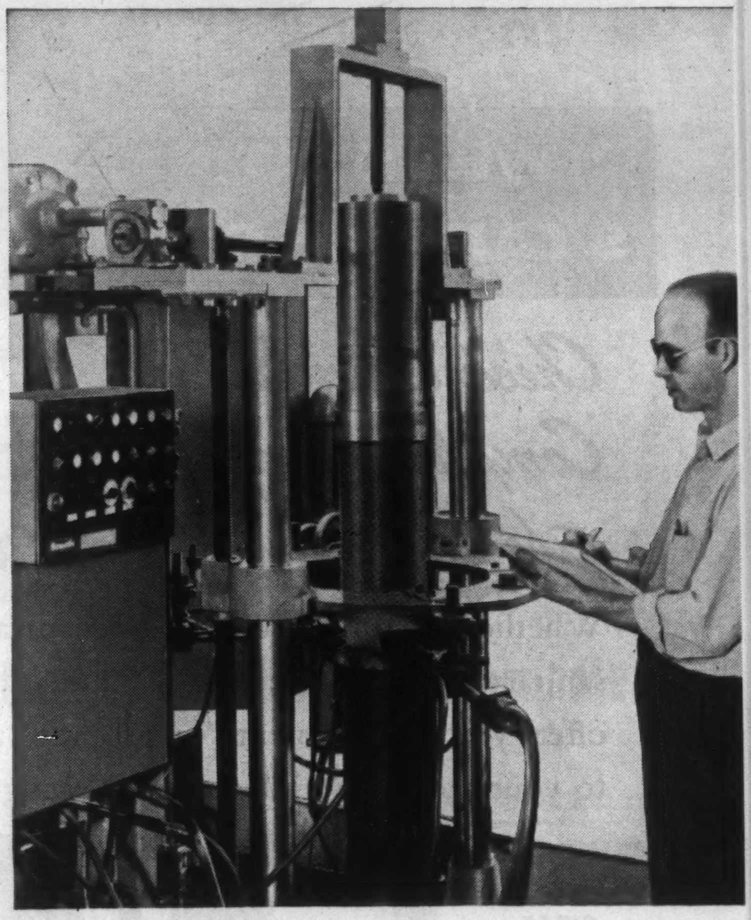
NO. 31 OF A SERIES

what's new?

flamatic-hardened radial column*



* CINCINNATI LATHE AND TOOL COMPANY'S NEW "HARDCLAD" RADIAL DRILL



Here's a Flamatic-hardened column that is designed to resist scoring and hold its accuracy substantially longer than conventional columns. This column, a new feature of the Cincinnati Lathe and Tool Company's radial, is a centrifugal casting of close-grained iron, surface-hardened on a special Cincinnati Flamatic machine which holds the piece vertically while the flame head assembly with integral water quench moves from bottom to end of flame hardened area.

If you make columns, rolls, or any cylindrical parts, check into Cincinnati Flamatic surface hardening. It may add years of accuracy and service to your products. And it may cost less—in initial investment and operating costs—than other hardening methods. Write for further information.

CINCINNATI **flamatic**

PROCESS MACHINERY DIVISION

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI 9, OHIO, U.S.A.

For more information, Circle No. 417

looking for the right tube in WELDED STAINLESS?

Check Standard's Complete Range of tube and pipe sizes!

Whether it's for a pressure, mechanical, sanitary or ornamental use – Standard offers you a convenient "one source" answer to your welded Stainless Steel Tubing need.

TUBE SIZES: ¼" to 4" OD .025 to .148

PIPE SIZES: ⅛" to 2" IPS Schedule 40

TYPES: 430, 302, 304, 309, 316, 321, 347; and others including low-carbon grades.

SHAPES: Squares, Rectangles and Special Shapes

PIPE SIZES: ⅛" to 4" IPS Schedules 5 & 10

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Detroit 28, Michigan
Welded Tubing · Fabricated Parts
STANDARDIZE with STANDARD — It Pays

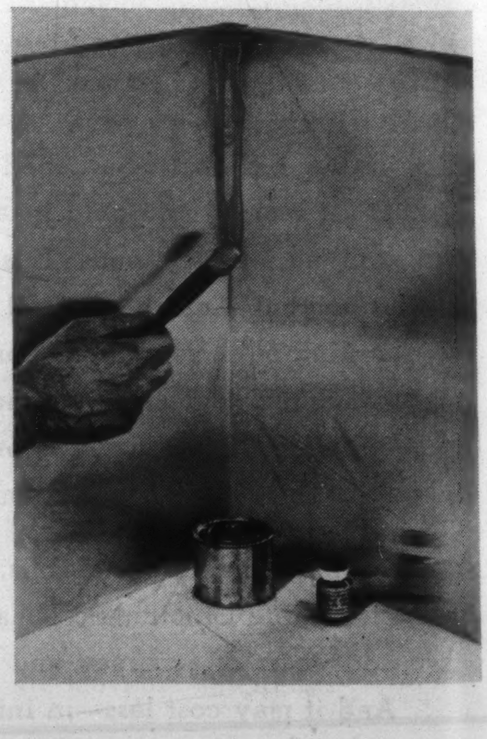
For more information, turn to Reader Service Card, Circle No. 433

New Materials, Parts, Finishes

Boltaron 8100 by *Bolta Products*, Lawrence, Mass. The impact strength of the formable sheet material ranges between that of modified styrene extruded sheets and styrene copolymer laminated sheets. It is available in a variety of colors and finishes and is designed for such applications as packaging units, point-of-purchase displays, bench assembly trays, refrigerator parts, business machine housings and similar items.

Typical physical properties of Boltaron 8100 Series are as follows:

Specific gravity	1.04
Tensile strength, psi	2200
Elongation, %	30-40
Izod impact, at 70 F, ft-lb/in. of notch	6
Shore hardness, D	74
Heat distortion, F	180
Shrinkage, %	3-5
Forming characteristics:	
Ring and plug	Good
Vacuum	Good



Metal-Epoxy Putty

An aluminum-filled epoxy putty for building up metal surfaces or for caulking seams and holes in metal and wood surfaces is being marketed by *Smooth-On Mfg. Co.*, Jersey City, N. J. Metalset A201 is an epoxy resin compounded

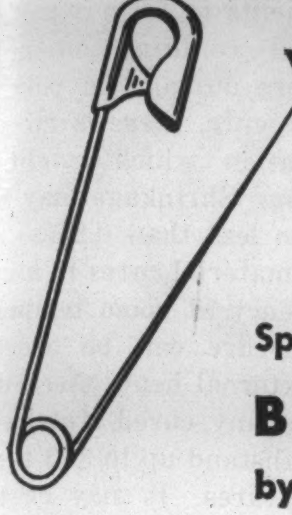
when

old-fashioned

fasteners

won't

work



Specify

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by BOOTS

New, self-locking threaded Inserts and Tapped Holes.

Designed primarily for materials too thin or too soft to sustain threads.

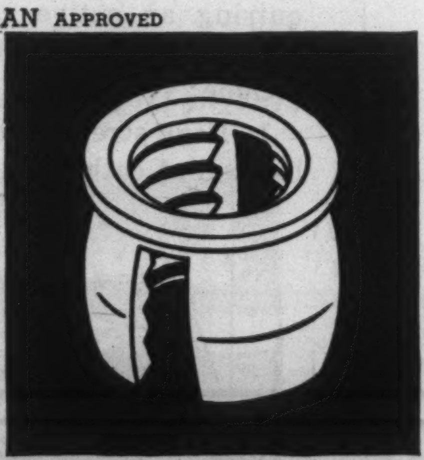
BANC-LOK threaded Inserts are ideal for blind fastening, economical, reusable and eliminate extra locking devices.

BANC-LOK Tapped Holes are designed for sheet materials too thin to tap.

BANC-LOK Inserts and Tapped Holes require no special tools . . . simply push into round holes. Available in aluminum alloy, **BANC-LOK** Inserts may be ordered in any size and material.

Write for samples and catalogue.

AN APPROVED



BOOTS Aircraft NUT CORPORATION

BANC-LOK DIVISION

532 NEWTOWN TURNPIKE • NORWALK, CONNECTICUT

For more information, turn to Reader Service Card, Circle No. 302

New Formica Q-125

10 times more arc resistant

than standard phenolic laminates

The unequalled arc and flame quenching performance of the new Formica Q-125 laminated plastic lies in this unique combination: (1) it's a paper base grade, (2) impregnated with special Formica resin and (3) contains no polyvinyl-chloride. It's excellent for radio-tv flyback transformers and printed circuits; also for switch gear, bus bar and circuit breaker insulation. For complete information . . .

Send for FREE descriptive data

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Pays in Performance

THE FORMICA CO.
4678 Spring Grove Ave.
Cincinnati 32, Ohio

Gentlemen: Please send me data sheet on new Q-125 listing all properties.

Name...

Company...

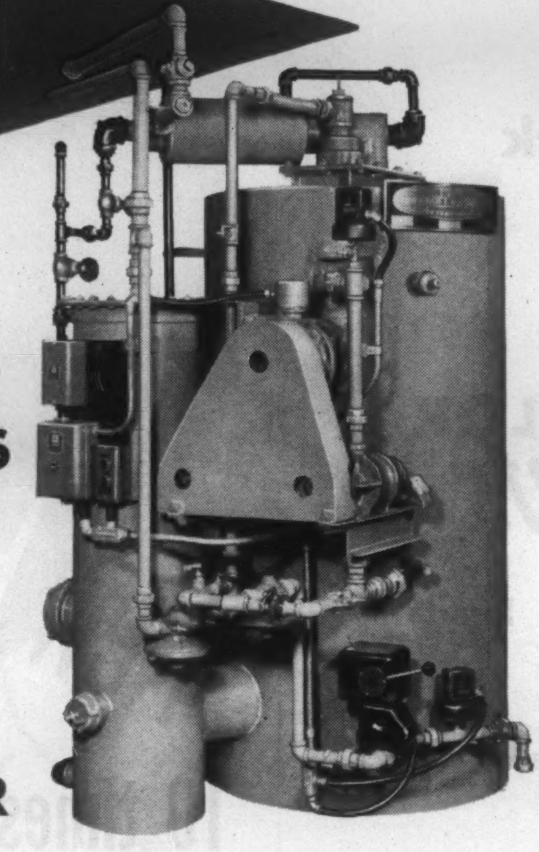
Address...

City.. Zone........ State........................

For more information, turn to Reader Service Card, Circle No. 482

Another

FIRST!



HOLCROFT'S
NEW
EXO-ENDO
GAS
GENERATOR

Holcroft has designed a radically-different exo-endothermic gas generator. Designed not only for the batch furnace but for other furnaces as well, the generator can produce gas atmospheres between the limits of perfect combustion and modified "302." At the latter setting, the gas generated has two main differences from a standard AGA Type 302 gas. The first is very much lower dewpoints—as low as minus 50 deg. F. with no detectable amounts of methane. In addition, the gas produced has an approximate 50% lower hydrogen content. This means that for a given carburizing potential, less hydrocarbon addition is necessary. The lower percentage of hydrogen is an added safety feature. The Holcroft process is covered by U. S. patent No. 2,589,810.

A slight adjustment at the generator can produce a non-explosive atmosphere to perform heat treating cycles below the explosive limits required for atmosphere tempering, annealing, and stress relief of ferrous alloys as well as hardening, annealing and tempering of non-ferrous alloys.

The new generator is an extremely compact unit (but 20 square feet of floor space is required.) The total gas used can be adapted to many manufacturing requirements.

If you have any kind of a heat treat problem—small or large—better call Holcroft.

HOLCROFT & COMPANY, 6545 Epworth Blvd., Detroit 10, Michigan.

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CANADA: Walker Metal Products, Ltd., Windsor, Ontario • EUROPE: S.O.F.I.M., Paris 8, France

For more information, turn to Reader Service Card, Circle No. 458

New Materials, Parts, Finishes

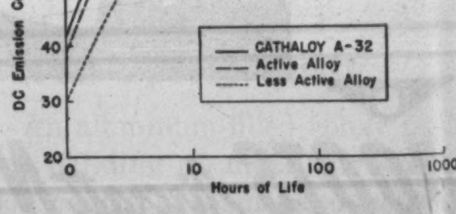
with aluminum filler and other ingredients to form a paste. The material contains no solvents; therefore during the polymerization, or cure, there is no solvent-evaporation which might cause cracking. Shrinkage may be kept down to less than 0.2%.

The material cures to a metallic consistency at room temperature, though cure can be accelerated with external heat. According to the company, cured Metalset A201 will withstand up to 300 F service temperatures. It may be tapped, drilled or machined by conventional methods and it has good adhesion and resistance to acids, alkalis and water. It is recommended for marine repairs above or below the waterline and for outdoor metal surfaces, including auto and truck bodies and aircraft structures.

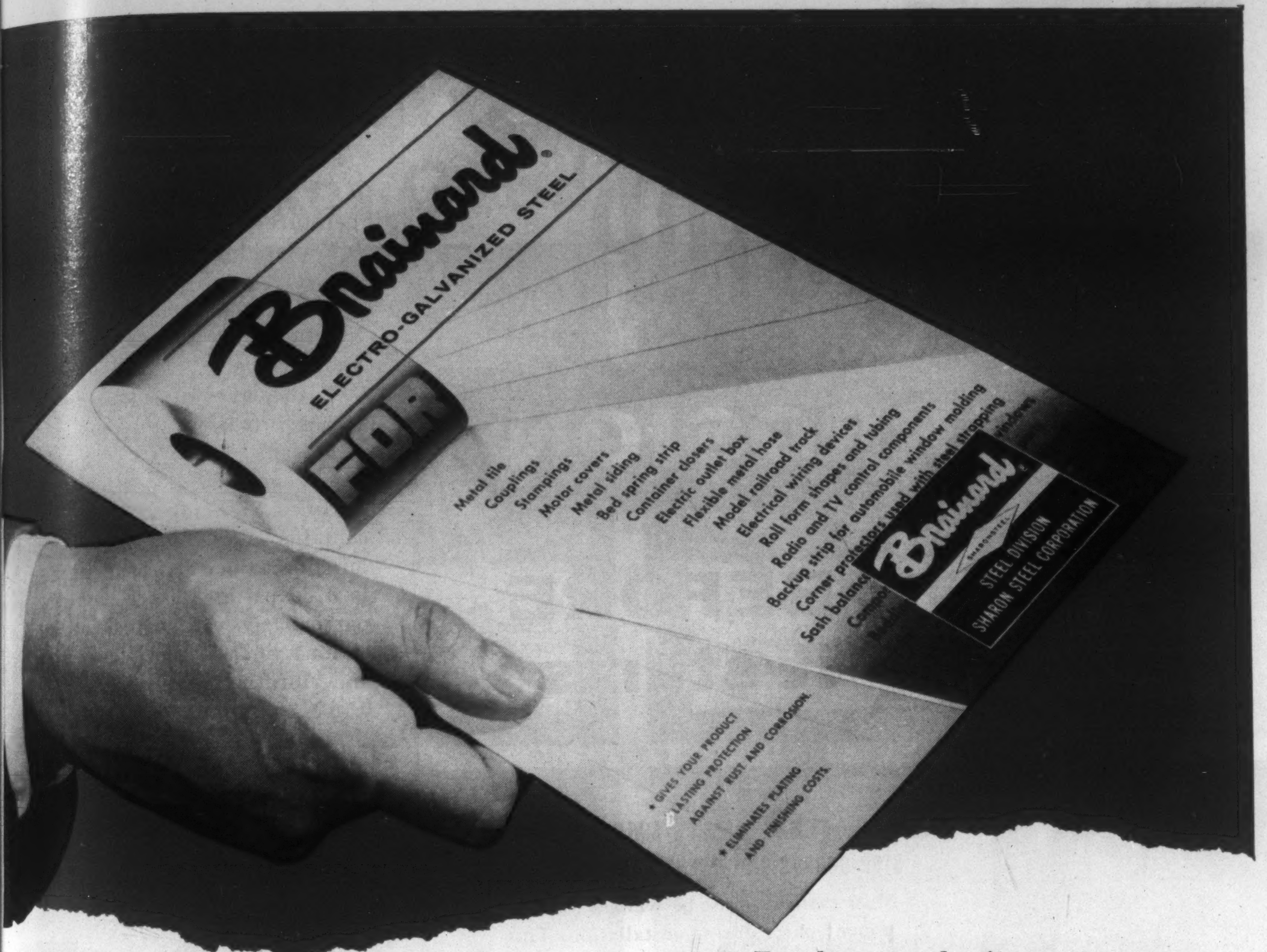
Active High Strength Cathode Alloy

A new active-grade cathode alloy, said to combine shock resistance with high emission characteristics, has been developed by *Superior Tube Co.*, 1548 Germantown Ave., Norristown, Pa. It is available in seamless, Weldrawn and lockseam cathode sleeves and can be used in electron tubes requiring an active cathode alloy. Features claimed for the alloy include:

1. High strength during assembly and at cathode operating tem-



Note uniform emission level *of new alloy as compared to other active alloys tested in ASTM standard diode.*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BEFORE
it starts

ESCO 0.03 MAX. CARBON STAINLESS CASTINGS STOP CORROSION... EVEN AT THE WELD

Most castings must be welded to component parts during installation. This usually means "carbide precipitation" and resultant corrosion along the weld, unless unit is heat treated—an always difficult, sometimes impossible job.

ESCO 0.03 Max. carbon castings can be welded into working position without loss of corrosion resistance—even at the weld. Result: Dependable corrosion-resistant operation. A definite cut in operating costs.

ESCO will produce to your specifications one casting or an entire installation. Spuncast®, Shellcast and conventional casting facilities are available. Write for details.

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Eugene, Oregon
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In Canada, Vancouver British Columbia and Toronto, Ontario

For more information, turn to Reader Service Card, Circle No. 303

peratures.

2. Rapid activation during tube processing.

3. Freedom from excessive sublimation during tube processing and life.

4. Low rate of interface impedance formation under all service conditions.

5. Long life.

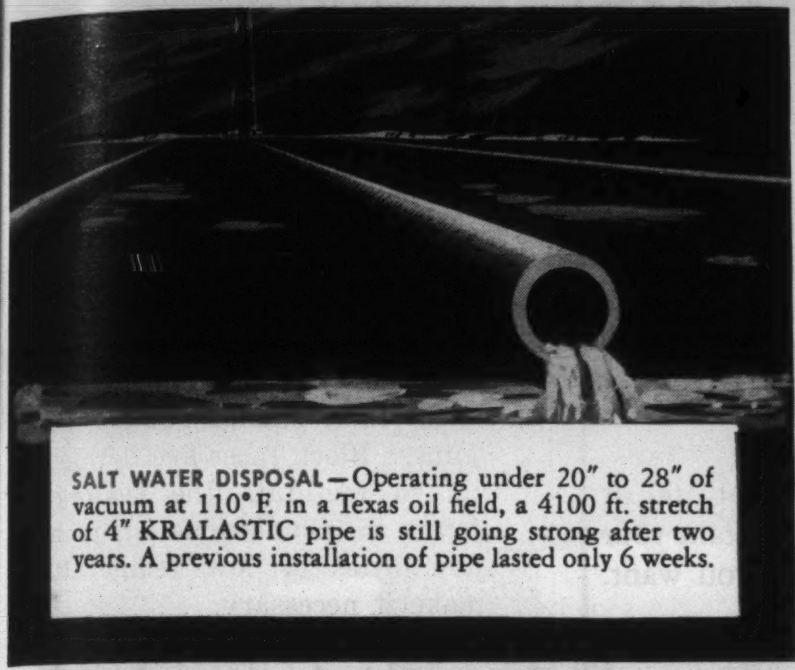
Called Cathaloy A-32, the alloy contains 2.25 tungsten-0.10% aluminum. Its hot deflection strength is 3750 psi at 1650 F, making it particularly well suited for applications where resistance to shock and vibration is required. Use of 0.10% aluminum as the active reducing element for the core coating reaction of the oxide cathode accounts for the freedom from excessive sublimation and the low interface impedance.

Cellular Glass Insulation

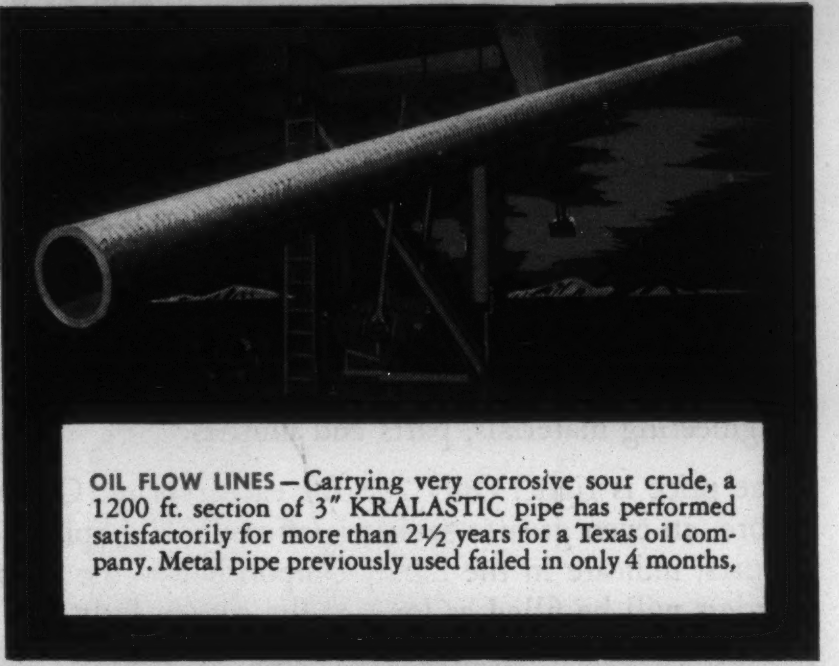
A cellular glass insulating material with a hard, impact-resistant ceramic surface has been developed by *Pittsburgh Corning Corp.*, Pittsburgh, Pa. Made of pure glass, the inorganic product does not rot or deteriorate, is not affected by fungus or vermin, is said to be moisture proof, and resistant to fire and nearly all chemicals.

Called Duraface Foamglas, the material is marketed in standard 12- x 18-in. blocks, in thicknesses of 3 or 4 in., depending on the

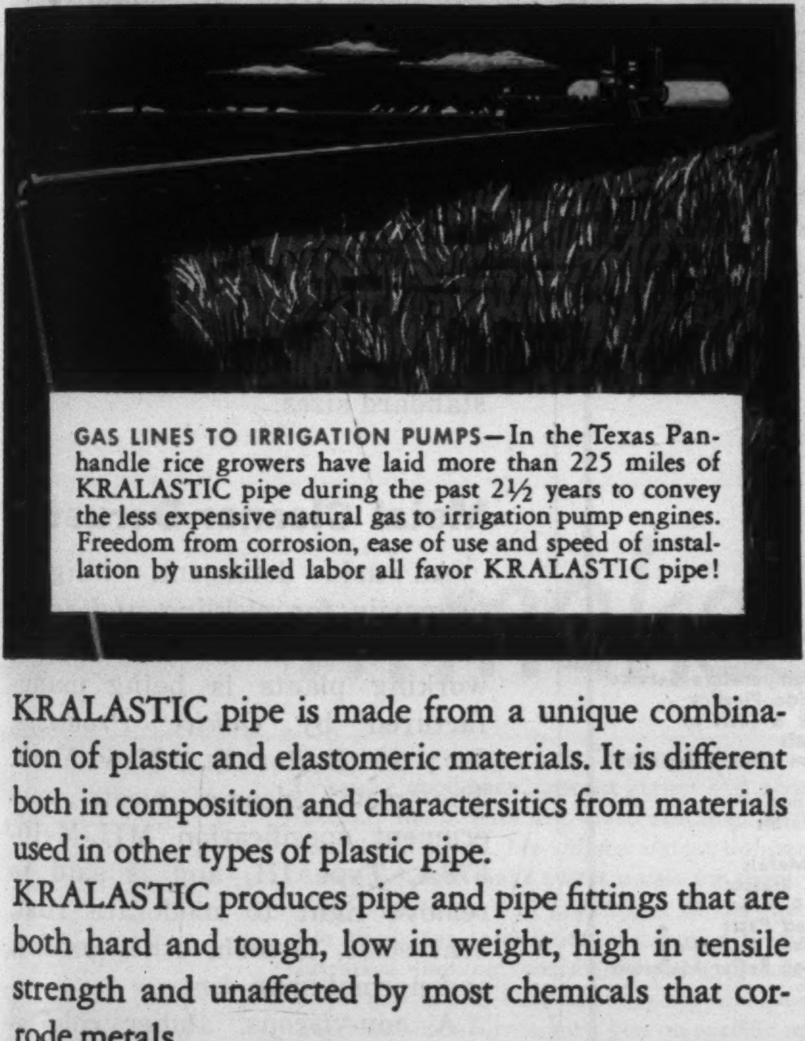
KRALASTIC Corrosion-Proof Pipe Makes Good in Many Fields!



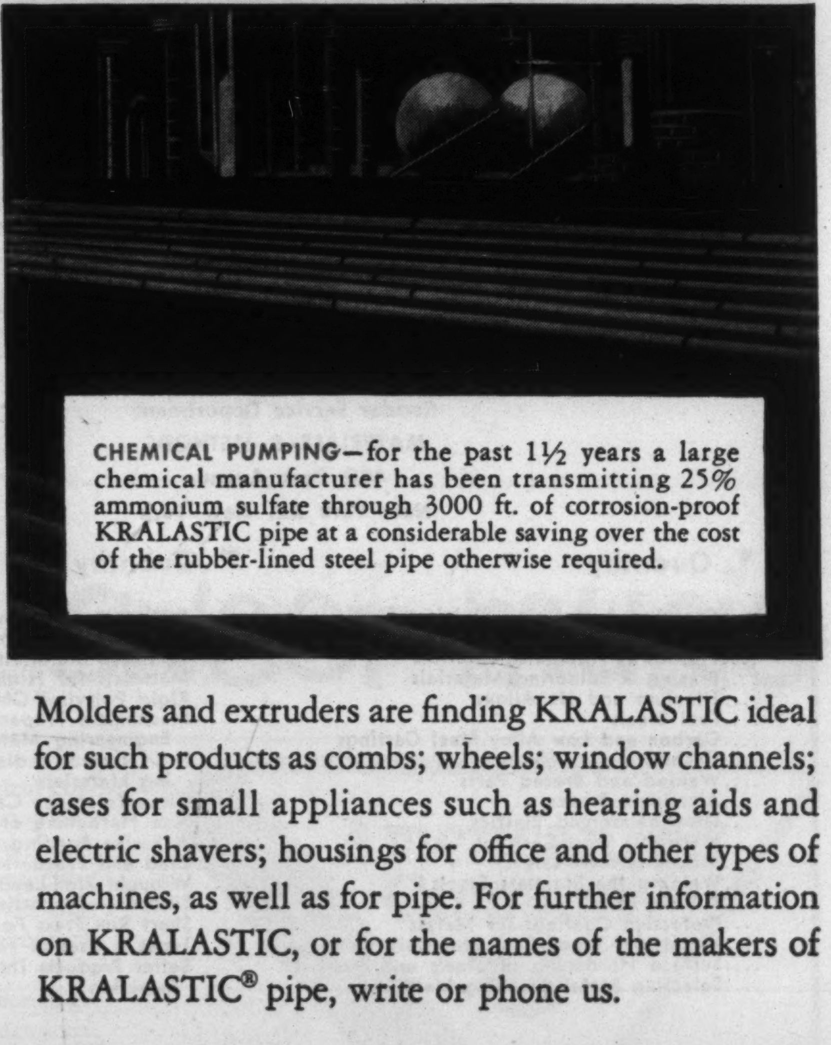
SALT WATER DISPOSAL—Operating under 20" to 28" of vacuum at 110° F. in a Texas oil field, a 4100 ft. stretch of 4" KRALASTIC pipe is still going strong after two years. A previous installation of pipe lasted only 6 weeks.



OIL FLOW LINES—Carrying very corrosive sour crude, a 1200 ft. section of 3" KRALASTIC pipe has performed satisfactorily for more than 2½ years for a Texas oil company. Metal pipe previously used failed in only 4 months,



GAS LINES TO IRRIGATION PUMPS—In the Texas Panhandle rice growers have laid more than 225 miles of KRALASTIC pipe during the past 2½ years to convey the less expensive natural gas to irrigation pump engines. Freedom from corrosion, ease of use and speed of installation by unskilled labor all favor KRALASTIC pipe!



CHEMICAL PUMPING—for the past 1½ years a large chemical manufacturer has been transmitting 25% ammonium sulfate through 3000 ft. of corrosion-proof KRALASTIC pipe at a considerable saving over the cost of the rubber-lined steel pipe otherwise required.

KRALASTIC pipe is made from a unique combination of plastic and elastomeric materials. It is different both in composition and charactersitics from materials used in other types of plastic pipe.

KRALASTIC produces pipe and pipe fittings that are both hard and tough, low in weight, high in tensile strength and unaffected by most chemicals that corrode metals.

Molders and extruders are finding KRALASTIC ideal for such products as combs; wheels; window channels; cases for small appliances such as hearing aids and electric shavers; housings for office and other types of machines, as well as for pipe. For further information on KRALASTIC, or for the names of the makers of KRALASTIC® pipe, write or phone us.

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New Materials, Parts, Finishes

amount of insulation required. The integral white ceramic surface is about ¾ in. thick. According to the company, a wall completely insulated and surface-finished may be erected in one operation. The blocks are said to have good rigidity and possess high compressive strength, making it possible to build unsupported walls. The blocks are installed with either straight or staggered joints. Block faces are beveled ¼ in. to facilitate the sealing of joints in installations where high humidities or low temperatures make it necessary.

Blocks of Duraface Foamglas are made from two mixtures of chemicals and glass pulverized as fine as talcum powder, and baked at 1700 F for 80 min. The gases which are given off at this temperature collect in bubbles of molten glass. After removal from the cellulating oven, the material is cooled at controlled temperatures for 12 to 14 hr. Finally, the blocks are faced and trimmed into standard sizes.

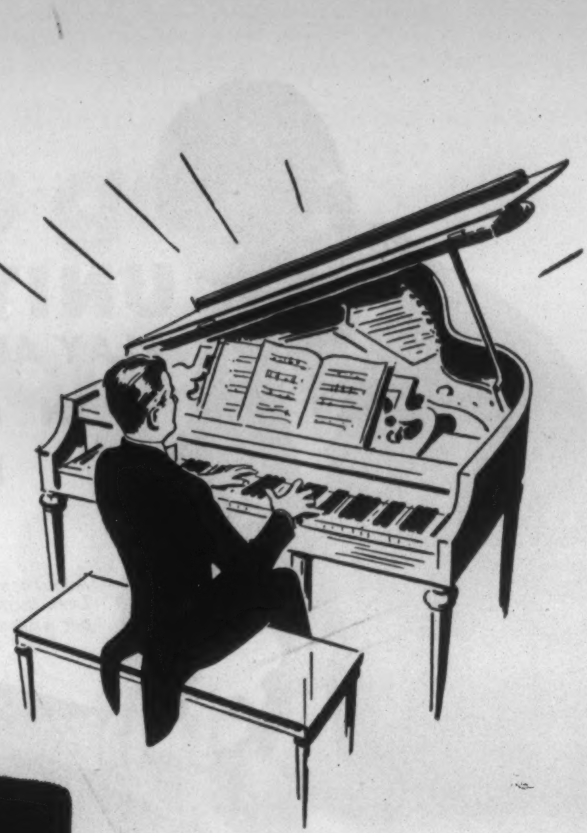
Metal Cleaner-Deruster

An acid detergent, designed primarily for pickling and scale-removal operations in metalworking plants is being manufactured by *Oakite Products, Inc.*, 19 Rector St., New York. The metal cleaner meets government specification MIL-M-10-578A, Type III, and is said to remove light to moderate rust, heat scale, tarnish, other oxides, and normal shop dirt.

A non-viscous, amber colored liquid, Oakite Compound No. 131 has a pH range of 1.0 to 1.5 at 70 F, and a bulk density of 11.0 lb per gal. Besides possessing rust-and soil-removing properties the compound is said to be an effective inhibitor for iron and steel. Soluble in water or alcohol in all proportions, No. 131 may be rinsed in both hot and cold water. Solutions are made by

American Quality

felt



...makes sweet music

Pianos contain American Quality Felt in various types to assure good tone, instant action and acoustical correction. Piano felts are most exacting, and American leads in this field. No wonder industrial users find that American felts make sweet music for them, protecting the performance and reputation of the machines that use them for lubrication, sealing, vibration control, filtration, honing, weatherstripping, insulation. It is important to select the right type of felt; American engineers will collaborate with you on specific applications.

American Felt Company
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PLAY AN IMPORTANT PART
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Accuracy cuts cost.
Less than 1 hour machining time is required per unit assembly with Unitcastings.

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..ADD UP TO TOP QUALITY PRODUCT!

A nationally known manufacturer of house trailer tow-bar mechanisms keeps quality up and costs down by specifying *Unitcastings*. Dimensional accuracy, internal soundness and good surface appearance hold finishing costs to a minimum and help retain customer acceptance. In less than six years of production and over 202,000 parts later, less than ½ of 1% of the total castings shipped have been returned for any reason.

Beginning with the original design of the castings, Unitcast's engineering service has kept pace too, by continually modernizing the design to suit automobile chassis improvements. This is just one of the many Unitcast Foundry Engineering Services available to our customers.

Let Unitcast help you modernize your product by including foundry standards in the design. Keep your production cost competitive. . .write today!

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QUALITY
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CASTINGS

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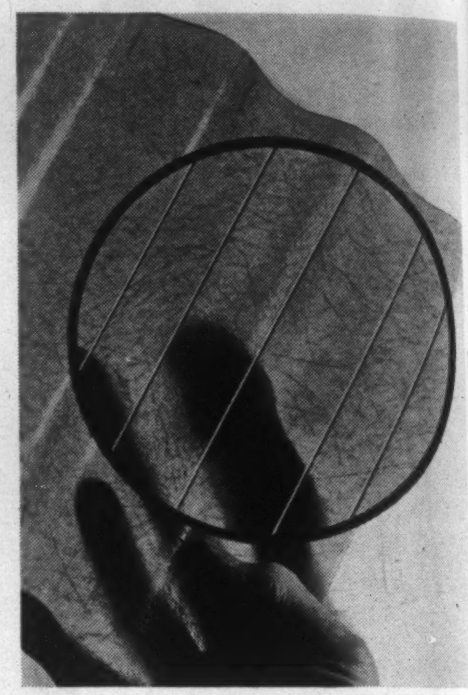
New Materials, Parts, Finishes

stirring the cleaner slowly into full volume of water, in a concentration range of 5 to 30% by volume. Recommended operating temperatures are from room temperature to 160 F.



Nylon, Glass in Reinforced Plastics Sheet

Parallel strands of nylon and random glass fibers form the reinforcement for a new translucent plastics sheeting material called Filon. According to the manufacturers, *Plexolite Corp.*, 2051 E. Maple Ave., El Segundo, Calif., use of nylon materially increases the rigidity, impact strength and resistance to heavy loads of the reinforced polyester panels. Company tests show that a panel weighing 8 oz per sq ft will support a load of over 200 lb per sq ft over a 4-ft unsupported area.

Filon panels are available in 20 colors, and improved pigment dispersion is said to result in uniform color throughout the panel. Panels are produced in crinkled and smooth finishes, and in 6- and 8-oz weights. In addition to standard sizes they are available in any lengths.

(*More New Materials on page 172*)

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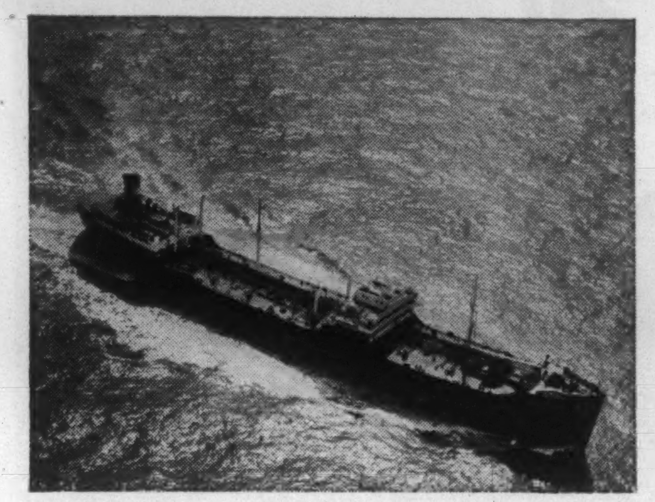
What's going on in

NON-FERROUS METALS

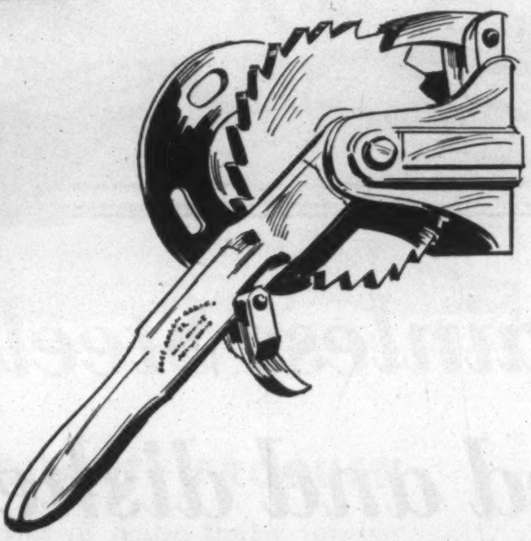
...stopping ship corrosion

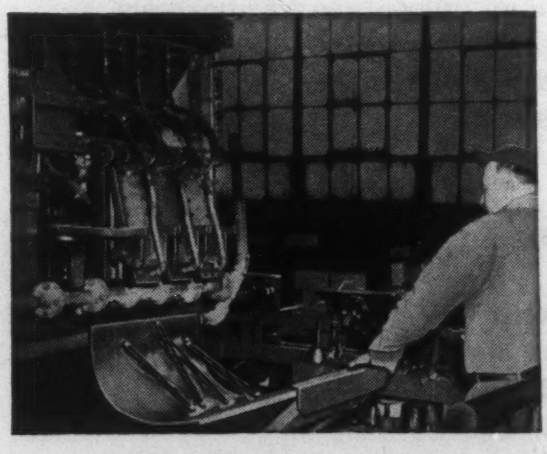


with Federated magnesium anodes. When designed and installed correctly, the low-cost anodes corrode and the high-cost ship does not. Saves thousands of tons of steel annually. Federated Metals has a Corrosion Advisory Service which works to help the marine, petroleum, natural gas and other industries. Literature available.

...aluminum ratchet

to tighten ridge rope on trailer trucks. This eliminates the cumbersome and heavy iron ridge pole, a long-standing trucker's headache. Weighs less than seven pounds. Cast of Tenzaloy, a Federated-developed high-strength aluminum alloy, by Littlestown Hardware and Foundry Co. for East Akron Ratchet and Mfg. Co. Tenzaloy bulletin on request.





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New Materials, Parts, Finishes

Epoxy Adhesive Bonds Metals

A new one-component epoxy-type metal adhesive is being manufactured by *Carl H. Biggs Co., Inc.*, 2255 Barry Ave., Los Angeles 64, Calif. for use in bonding ceramics, glass, and metals. Supplied in paste form ready for use, Bonding Agent R-385, is cured by baking 1 hr at 325 F. No pre-assembly drying or pre-cure of the black compound is necessary. According to the company, the pressure exerted during baking operations is all that is required to effect the bond.

Physical properties of R-385 are:

Specific Gravity	1.18
Compound Strength, psi	18,000
Shear Strength, psi	
Room Temp.	3500
At 180 F.	1800
At 250 F.	1500
Heat Resistance	−60 to 500 F (can withstand higher temperatures for short period of time)

The bonding agent is a thermosetting compound which is said to be chemically inert to concentrated acids and alkalies at room temperature, and to more dilute solutions at elevated temperatures.

Sprayed Vinyl Guards Metals From Corrosion

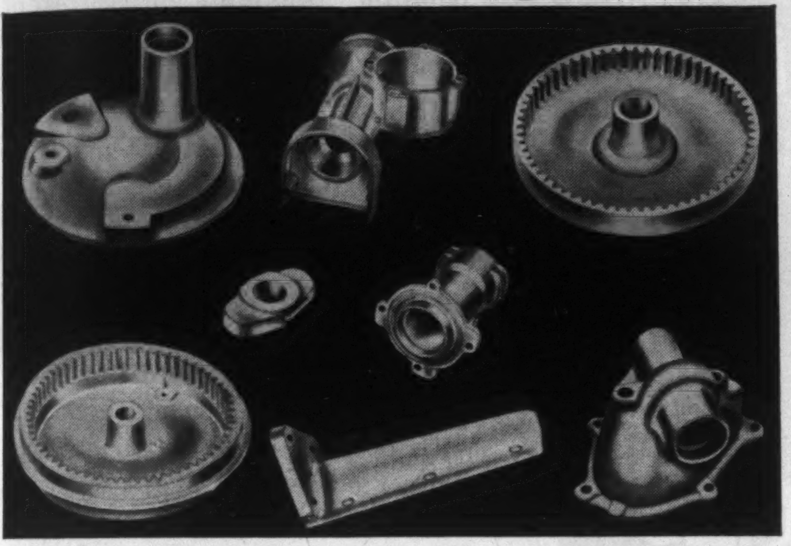
Three new vinyl protective coatings which can be applied by spraying, have been developed by three companies. Two are designed for hot spraying, while the other can be sprayed at room temperature.

Two hot-spray coatings

Increased film build-up per spray coat and reduction in overspray losses are claimed for Hot Spray Vinyl, developed by *Prufcoat Laboratories, Inc.*, 50 E. 42nd St., New York 17. Optimum build-

Mow Down Your Grass Cutter Costs

Aluminum and Magnesium Die Castings



The increased use and acceptance by the public of power mowers has been tremendous . . . in large, this has been due to the choice by their manufacturers of lightweight aluminum and magnesium die cast parts. They help make these rotary and reel-type lawn mowers efficient and attractive, along with the attainment of competitive position in the retail market. Too, the savings in weight effected by these new lightweight alloys have an important bearing on consumer acceptance and save the manufacturer considerable in shipping costs. Greatly important to the manufacturer are the major production cost savings through the minimizing or virtual elimination of machining operations, plus the providing of smooth surfaces and design flexibility. As shown in the photograph, magnesium and aluminum alloy die castings have proved to be ideal for such lawn mower parts as: wheels, gears, gear housings, shaft housings, brackets, spacers, frames, cutter bar supports, etc.

Let's Talk It Over . . .

LITEMETAL DICAST, INC. is an organization of specialists — men thoroughly experienced in the casting and machining of magnesium and aluminum alloys. Our equipment includes big machines for big jobs — little machines for little jobs . . . the right sizes and types of the most modern die casting equipment for producing parts from the size of a button to large cable spools. Complete facilities for secondary operations are also available.

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REN-ITE PLASTIC IS THE ANSWER

Ren-ite—the dimensionally stable tooling plastic—is flying high in the esteem of aircraft engineers . . . "Faster", "Easier", "Tooling time cut up to 70%" are some of the claims made for Ren-ite by the Aircraft Industry.

Some Ren-ite aircraft applications—master models, dies, drill fixtures, stretch press forms, routing fixtures, skin panel checking blocks, checking fixtures, inspection gauges, assembly fixtures and many others and Ren-ite research is developing many more.

Ren-ite is thermosetting epoxy resin for use as a laminating plastic without application of heat or pressure for general tooling applications . . . unaffected by moisture or temperature change, resistant to acid, alkali, grease or common organic solvent action.

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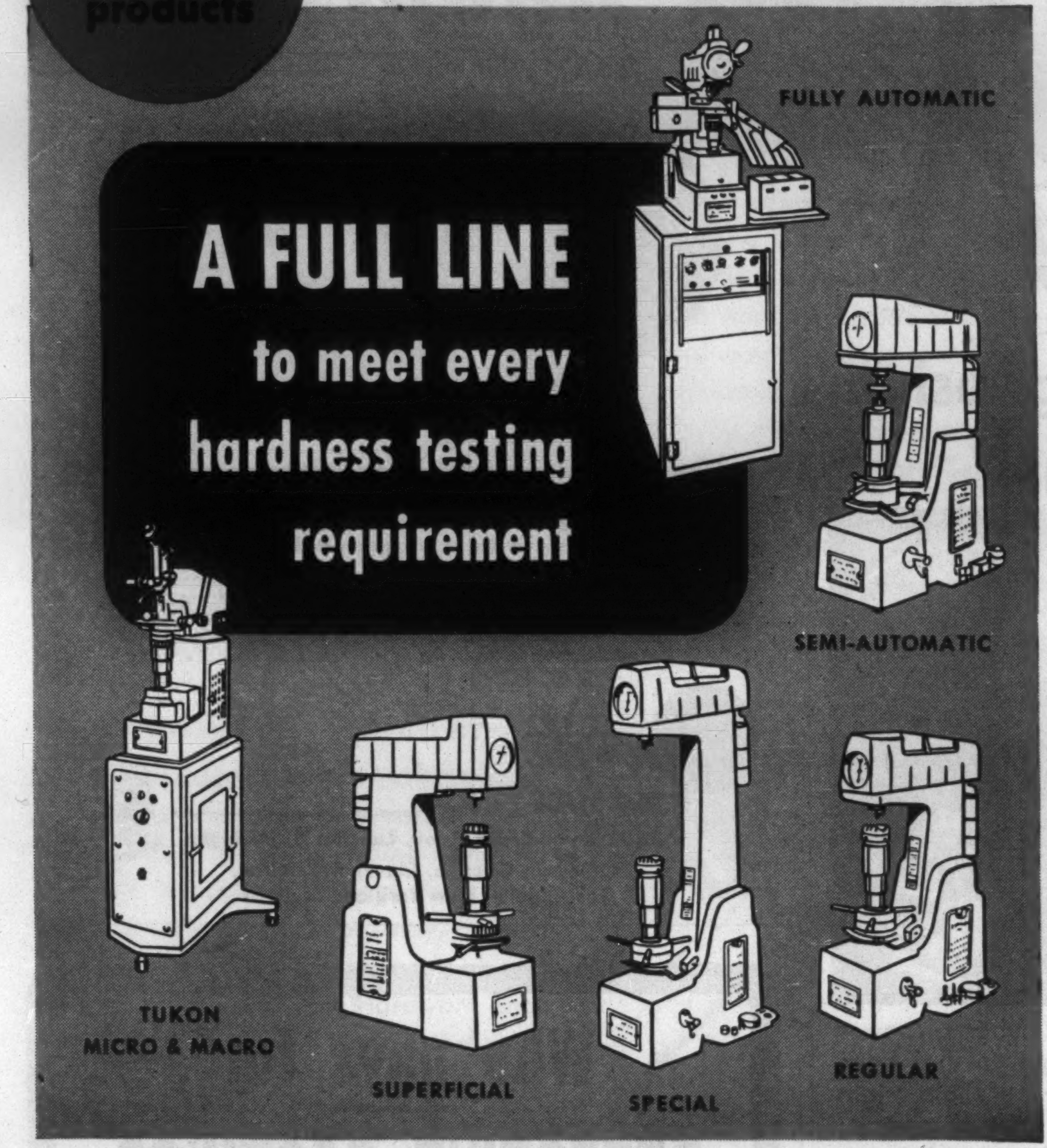
ACCO products

Wilson "Rockwell"* Hardness Testers



• Hardness testing standards of the metal industry have been set and maintained by WILSON "Rockwell" Hardness Testers since 1921. In steel mills, non-ferrous mills and metal fabricating plants everywhere, WILSON "Rockwell" standards have been the mark of perfection for a generation.

What is your testing problem? Whether your material is hardened steel, sheet metal, small parts, tools, rounds, tubes, soft metals or plastic materials—all are tested quickly and accurately by one of the many WILSON models.

WILSON "Rockwell" precision has made them the standard by which all other hardness testers are compared. The WILSON full line makes it unnecessary to compromise with less than the tester most suited to *your* requirement.

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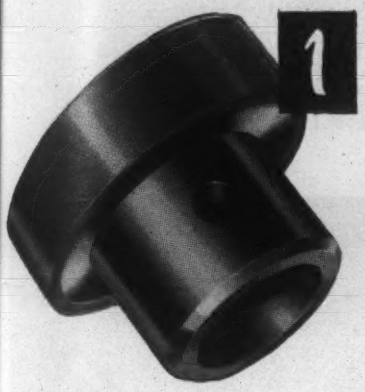
up per single spray is said to be about 4 mils, though 5 mils have been attained in some cases. Multiple passes with the material permit vinyl thickness in the 10-15 mil range without runs or sags, according to the company. Hot Spray Vinyl application is carried out at fluid tank pressures of 15-20 psi as compared to 40-45 psi pot pressures normally used in cold spraying and at corresponding atomizing pressures of 20-40 psi. The coating is applied at temperatures of 150-165 F, in which range there is less than 4% variation in viscosity of material. Additional advantages claimed for the material include fewer coats and faster application, lower total cost per square foot of surface, no necessity of thinners, better spraying conditions for workers, and a dense, thick film with heavier build-up on hard-to-protect edges and projections.

Another hot-spray vinyl-base film has been developed by the *U.S. Stoneware Co.*, Akron 9, Ohio. Combining vinyl with other plastics resins, Tygon ATD is said to form a high-solids-content, viscous material that reverts to liquid form on application of heat, thus avoiding use of excessive amounts of solvents to achieve spraying consistency. It is sprayed at a temperature of around 160 F, at an air pressure of 20 lb and atomizing pressure of 50 lb of air. As the hot paint leaves the spray gun, most of the incorporated solvents evaporate and a thick high solids content film is deposited on the surface. Drying time is short.

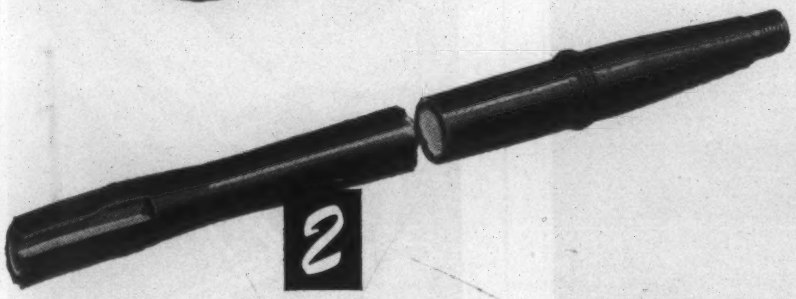
High solids cold-spray

A new vinyl mastic protective coating which is applied at room temperature has been developed by *Amercoat Corp.*, 4809 Firestone Blvd., South Gate, Calif. According to the company, the coating can be applied at a thickness of 10 mils in one double-pass spray coat. Called Amercoat No.

7 WAYS to SAVE MONEY with TOCCO* Induction Hardening

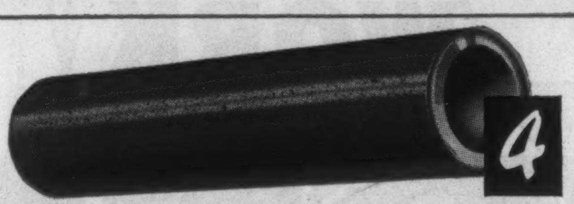


Cost was reduced 94% when heat-treatment of this corn-harvester part was changed from carburizing to TOCCO-hardening, 9½c saved on every piece — $4750 on each 50,000 piece batch, plus an hourly production increase from 120 to 300 pieces per hour.



$375 per day! When Salisbury Axle switched to TOCCO-hardening axle shafts. Less machining—30 seconds instead of 2 minutes—means lower tool cost. Also production zoomed from 50 to 120 per hour. TOCCO hardened shafts have 200% greater torsional life.

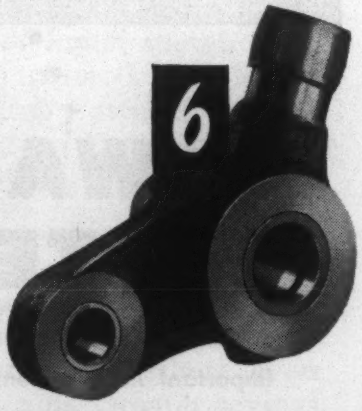
Kearney & Trecker Corp. reduced the cost of hardening this milling machine part from $1.57 to 10c apiece. In addition TOCCO made possible a switch from alloy to S.A.E. 1045 steel—saving another 11c per piece in material cost. Kearney & Trecker hardens 140 different parts on one TOCCO unit.



Thompson Products Ltd. boosted production of these automotive wrist pins from 500 to 1200 per hour when they switched to TOCCO-hardening. Costs fell from $5.45 to $3.25 per hundred parts—a savings of 2c per pin, $26.40 per production hour.

Mechanics Universal Joint Division of Borg-Warner reports a 69% savings in the hardening of stub ends for propeller shafts. TOCCO also upped production from 35 to 112 parts per hour—over three times as fast as conventional heating methods.

Lima-Hamilton Corporation adopted TOCCO for hardening this shifting lever. Results: a savings of 4c per piece—$25 per production hour. TOCCO costs only 17% of former heating method. This is only 1 of 139 parts TOCCO-hardened by Lima-Hamilton Corp. All show savings over usual heating methods.



7 Number 7—the lucky number—is up to you. Why not add your name to the list of companies who use TOCCO Induction Heating to increase production, improve products and lower costs. TOCCO engineers are ready to survey your plant for similar cost-saving results—without obligation, of course.

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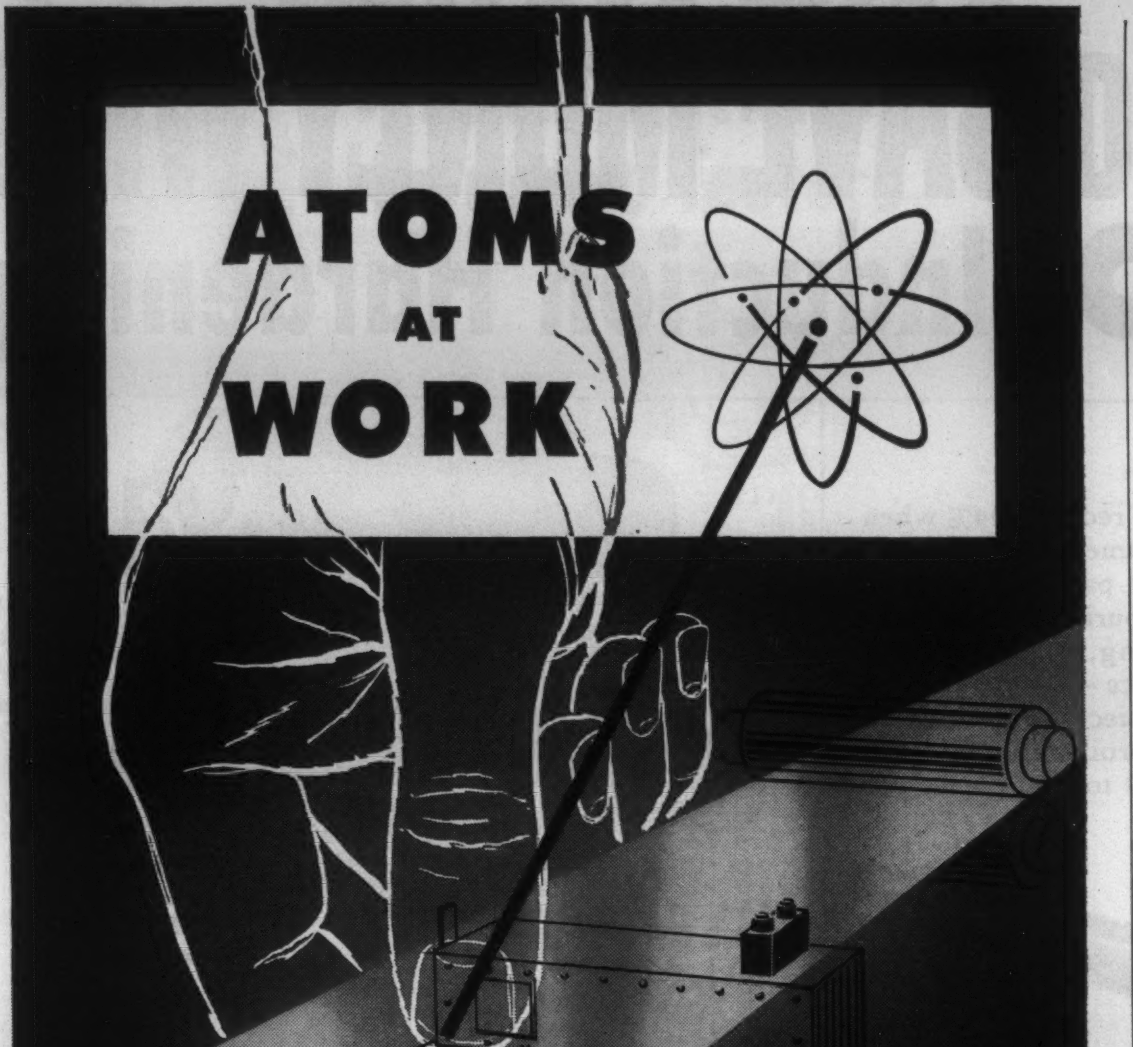

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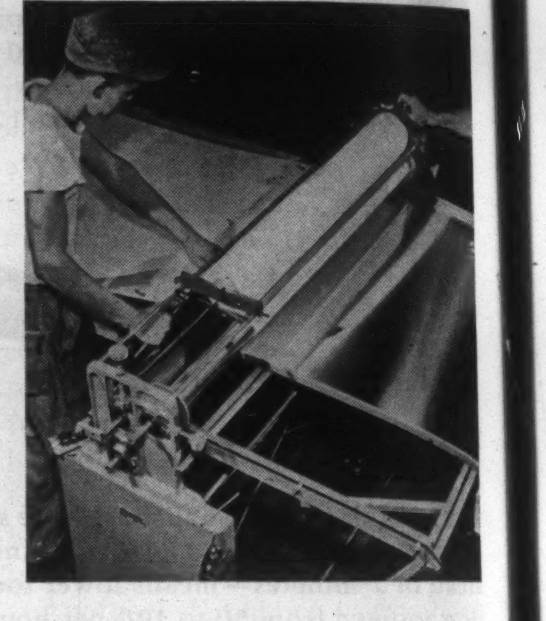
87, the coating is said to have a non-volatile content in excess of 55%. The density of the coating minimizes flow away from edges and sharp corners. An increase in vinyl content is due to new combinations of solvents in the coating, according to the company.



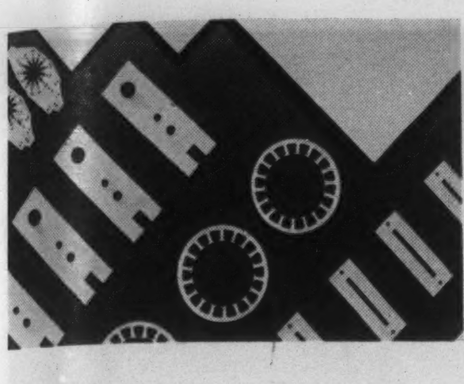
Machine Applies Protection to Polished Materials

A new roller applicator developed to coat polished sheet materials with protective pressure-sensitive adhesive paper has been marketed by *L. R. Wallace & Co.*, 191 N. Pasadena Ave., Pasadena, Calif. Called the Walco Power Applicator, the machine applies protective paper to a variety of materials including sheets of polished stainless steel, plastics, aluminum and glass at rates of approximately 30 ft per min.

Another machine recently developed by the company is a roller coater capable of coating one or both sides of sheet materials with adhesives or other types of coatings. It is said to be particularly adaptable to applying adhesives to honeycomb materials as well as to plywood and other flat surfaces. It is available in roller lengths from 10 to 72 in.

(More New Materials on page 179)

New Materials, Parts, Finishes



Plastics Laminates Resist High Humidity

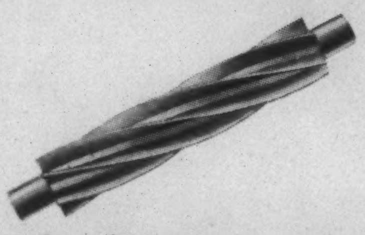
Three new grades of thermosetting laminated plastics based on a DAP (diallyl-phthylate) resin have been developed specifically for electrical applications in damp, humid climates. Produced by *Synthane Corp.*, Oaks, Pa., the grades are coded according to reinforcing material. The DAP resin is used to impregnate canvas in Grade C-104, Orlon in Grade O-104, and woven glass cloth in Grade G-104.

C-104 is the least expensive and, due to its canvas reinforcing, is easily machined and possesses good dimensional stability. O-104 is said to have a power factor and dielectric constant which show little change after NEMA water immersion tests. G-104 has the best electrical properties in dry condition, but shows a somewhat higher rate of change compared to other grades when subjected to moisture. Maximum operating temperatures vary between grades. According to the manufacturer, tests indicate that glass-reinforced DAP will withstand continuous temperatures of 325 F, canvas 275 F, and Orlon 225 F without affecting mechanical or electrical values.

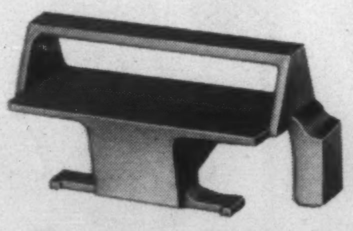
Laminates are available in sheet and tube form or as parts fabricated to specifications. Sheet thickness ranges from 1/32 to 1 in. in the canvas or Orlon, while glass fabric-reinforced DAP is available in thicknesses of 1/64 to 1 in.

FACTS ABOUT ATLANTALLOY PRECISION PLASTER MOLD CASTINGS

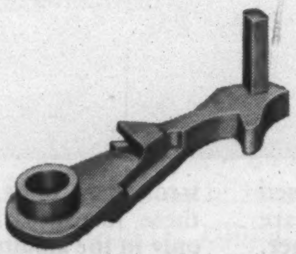
• ATLANTALLOY PRECISION PLASTER MOLD CASTINGS • ATLANTALLOY PRECISION PLASTER MOLD CASTINGS • ATLANTALLOY PRECISION PLAST



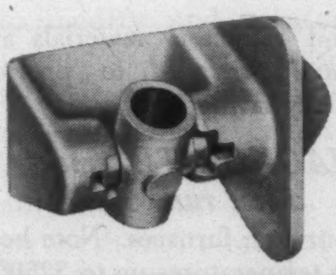
One-piece cast ice cutter for York Corporation's Automatic Ice Maker replaced fabrication of several stainless steel parts.



Cast brush holder for General Electric aircraft generators lowered costs, provided closer tolerances and increased strength.



Lever casting of *Atlantalloy* #31 manganese bronze with tensile strength of 100,000 psi for Sargent & Greenleaf's manipulation-proof lock.



Rugged skirt door operating mechanism cast for Pennsylvania Railroad cars manufactured by the Budd Company.

Today, ATLANTALLOY CASTINGS are used where precise dimensions and high physical values *plus* economy are essential. These unique precision plaster mold castings can improve *your* product design and reduce *your* costs:

PRECISION — Meet precision machining tolerances. Average limits, ± .005 on one side of parting line. Minimal or no machining or finishing.

DESIGN — Compared with other techniques, this casting process makes possible the production of parts which, because of high physical properties, could not economically be produced by other means. Complicated assemblies requiring several machined parts can be cast accurately as one piece, including designs having internal teeth, stops and blind gear teeth. A wide range of *Atlantalloys* are available for your design needs. Chemical certification on request.

EXCLUSIVE CASTING FEATURES — No gas formation when metal enters mold, and no ebullition of liquid metal. Self-venting molds yield to metal, cool slowly. Castings are practically stress-free with superior grain structure. Loose cores permit "impossible" designs. Finishes are exceptionally smooth and clean.

ECONOMY — Major savings in machine work because of high finish, uniformity and accuracy. End costs below machined parts from rougher-type castings, *even for limited volume runs.* Greater savings for large runs. Time and material savings since uniform castings always fit your jigs and fixtures without rejects. Tool life extended because castings have no blow holes, hard spots, or inclusions.

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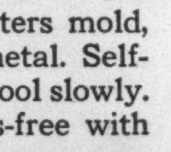
More facts on "High Quality Precision Castings for Industry". Write for your free copy!



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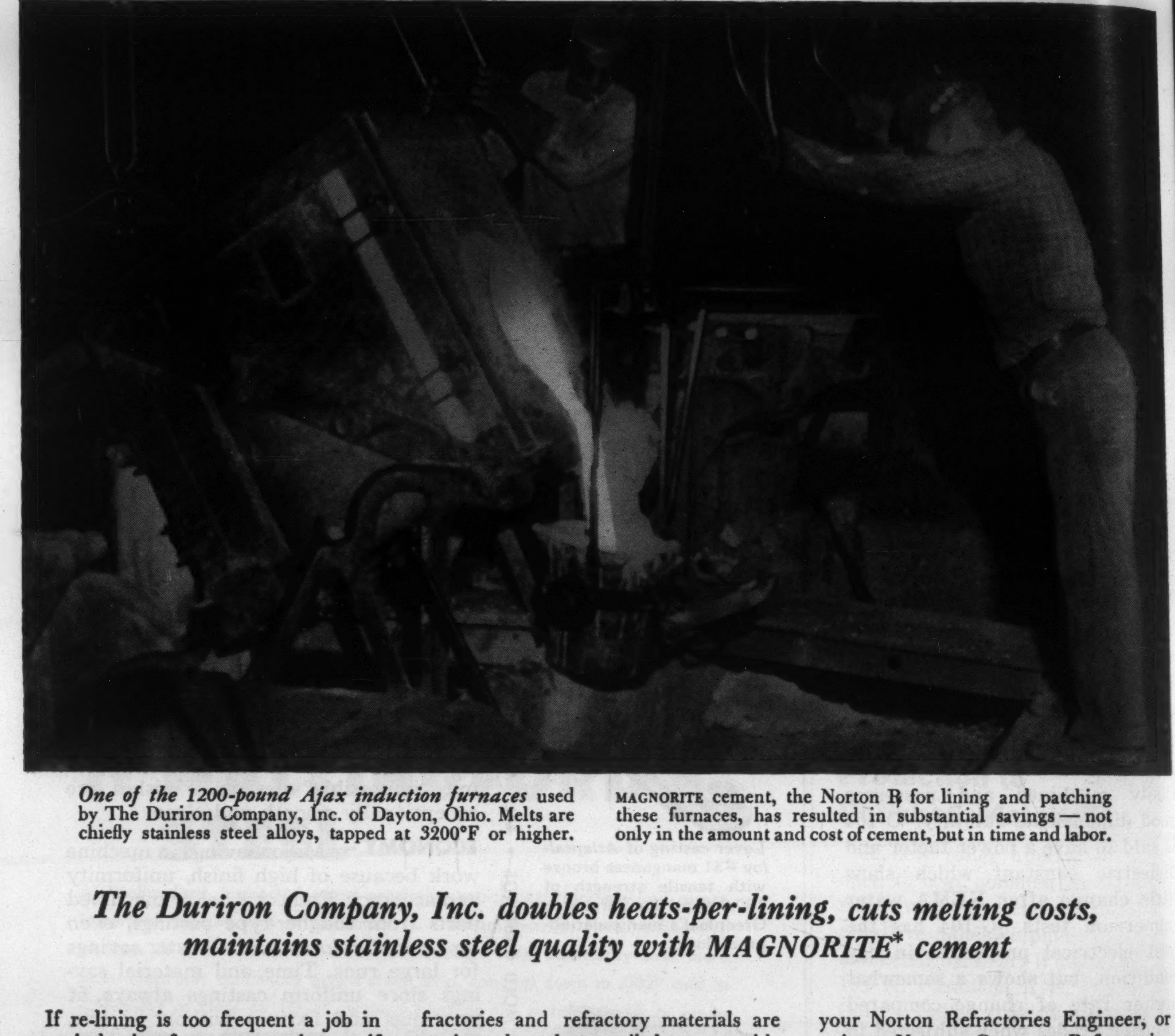
Another Norton ℞ on the job!



One of the 1200-pound Ajax induction furnaces used by The Duriron Company, Inc. of Dayton, Ohio. Melts are chiefly stainless steel alloys, tapped at 3200°F or higher. MAGNORITE cement, the Norton ℞ for lining and patching these furnaces, has resulted in substantial savings — not only in the amount and cost of cement, but in time and labor.

The Duriron Company, Inc. doubles heats-per-lining, cuts melting costs, maintains stainless steel quality with MAGNORITE* cement

If re-lining is too frequent a job in your induction furnace operations — if you're using up too much time, cement and money to get maximum heats — we suggest you consider MAGNORITE cement.

Take the experience of The Duriron Company, leading manufacturers of chemical process equipment made of stainless steel and other metals. Before trying MAGNORITE cement, their best previous lining material was giving an average of 68.2 heats per lining. Thorough test runs of MAGNORITE at the Duriron foundry show this Norton refractory material is averaging 140.5 heats per lining. And it is not only lasting twice as long as its best performing competitor, it is more refractory, it has 50% less slag volume on heats, and its freedom from shrinkage eliminates cracking. Another instance of how Norton refractories and refractory materials are *engineered and prescribed* to provide time-and-money-saving ℞'s.

Give MAGNORITE cement a test run

in one of your own furnaces. Note how it withstands temperatures up to 3250°F — how its high-rammed density resists metal penetration, erosion and chemical attack — how its slight expansion when sintered eliminates shrinkage cracks in the crucible lining.

Norton will be glad to specify MAGNORITE cement to your exact requirements, or to help you solve metal-melting problems. Working with MAGNORITE*, ALUNDUM*, CRYSTOLON* and Fused Stabilized Zirconia cements, Norton engineers will find ℞'s you need for efficiency and economy. For details, see your Norton Refractories Engineer, or write to NORTON COMPANY, Refractories Division, 344 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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Contents Noted

A digest of papers, articles, reports and books of current interest to those in the materials field.

This Month:

- *Plastics-rubber blends*
- *Effect of metal substructure*
- *Inhibitors guard against corrosion*
- *New test for organic coatings*
- *Uses for permanent magnets*

Developments in Plastics-Rubber Blends

In recent years, the fields of plastics and rubber have grown closer together. Processing methods are similar and it has been found that by blending the two materials, a third material can be formed, the properties of which differ from either of the original two. Of course, there are various types of plastics and various types of rubbers. By blending certain ones in proper proportions advantageous combinations of properties can be gained. In the February issue of the SPE *Journal*, F. A. Martin of the Hoover Co., edited a symposium of a number of papers describing several rubber-plastics blends, their properties and applications.

Styrene-butadiene and rubber

Two papers, one by C. R. Holt of Marbon Corp., the other by H. S. Sell of Goodyear Tire and Rubber Co., discuss blends of styrene - butadiene and rubber, both rigid and non-rigid compounds. Uncompounded styrene-butadiene resins are not particularly useful as end-product materials. Their value lies in materials produced by compounding them with rubber. The rubber may be used in small amounts to modify the basic properties of the resin, producing rigid or semi-rigid materials. Or the copolymer resin may be used to reinforce or modify the rubber, producing a non-rigid compound.

Resin-rubber blends where the resin comprises 60% or more of total composition generally have excellent impact - strength, high tensile and hardness, good electrical properties, low specific gravity, bright colors and good low-temperature properties. Practically all machine operations such as sawing, drilling, buffing and sanding can be performed readily. Resistance to inorganic chemicals can normally be considered very good.

The following properties are typical:

Tensile Strength, psi	3000-6500
Elongation, %	1-100
Hardness, Shore D	60-80
Impact Strength, Izod, ft-lb/in. of notch	10-100
Specific Gravity	1.00-1.15
Flexural Strength	6-12,000
Heat Distortion, F	105-175
Brittle Point, F	—40 to —60

The high styrene resins can be plasticized with a number of types of rubber plasticizers, but natural and synthetic rubbers are by far the most interesting. GR-S and high nitrile Buna N's are especially compatible as well as natural rubber and neoprene. GR-I does not seem to be compatible.

Using styrene-butadiene resins to modify and reinforce rubber produces the following results: an increase in hardness and stiffness and improvement in tensile strength, elongation, tear strength, abrasion resistance, hot tear strength and electrical properties. Blending does not materially alter the brittle point of the rubber but it does greatly improve the aging characteristics of natural rubber. In addition to improving physical properties, styrene-butadiene resins possess the lowest specific gravity of any non-discoloring and non-staining reinforcing material available. They also reduce shrinkage of the batch and act as plasticizers and processing aids at stock processing temperatures.

Styrene-acrylonitrile and rubber

To overcome the inherent brittleness of polystyrene, other monomers such as acrylonitrile have been used for copolymerization with styrene. These copolymers have better solvent resistance, heat distortion and impact strength than polystyrene. W. C. Crater of Naugatuck Chemical Co., points out that carrying this a step further by combining styrene-acrylonitrile resins and butadiene - acrylonitrile rubbers, a marked increase in toughness is provided with little sacrifice in hardness and heat distortion of the unmodified resin. The number of elements in the mixture provides a great deal of flexibility and a variety of materials with differing characteristics.

In general, the series of available molding and extrusion compounds feature toughness and good rigidity; dimensional stability; functionality; easy formability; chemical and strain resistance; good electrical properties; low specific gravity; and versatility.

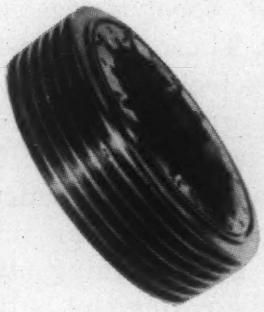
Phenolics and rubber

Phenolic resins and most rubbers are inherently incompatible. However, most phenolics do have a degree of compatibility with nitrile type rubbers. According to R. C. Bascom of B. F. Goodrich Chemical Co., this compatibility is limited, and the most useful cured blends of phenolic resins and nitrile rubbers are made with highly modified resins and nitrile

What makes **DUREZ** the preferred

PLASTIC for **RADAR**

storm-detector "vertebrae"?



● As soon as defense requirements permit, airlines, utilities, farmers, and others whose operations depend on accurate weather information will have access to a new medium of accurate storm warnings. It's a detector that records with automatic cameras the behavior of storms up to hundreds of miles away . . . distance, height, course, and speed.

At its electronic nerve center is a column of eight plastic "vertebrae" whose properties could have profitable applications in your business. Molded of Durez phenolic by the Auburn Button Works, they are dimensionally stable, unaffected by high and low temperature extremes. Signal fidelity is safeguarded by the electrical resistance of the material, it is non-reactive to the silver slip rings it holds in position, and Durez conforms to close tolerances in molding.

Specialized research at Durez has developed many remarkable combinations of characteristics in these basic plastics of industry. Could they lower your costs — improve your products? We'll gladly help you find out.

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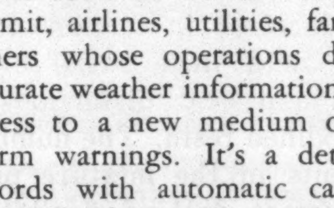
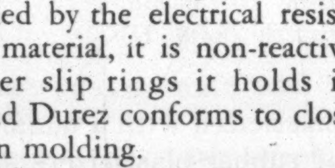


MOLDING COMPOUNDS. Structural, electrical, and chemical properties in many combinations.



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rubbers with acrylonitrile content on the order of 40%. Mr. Bascom goes on to discuss various processing difficulties and end results. The rubber increases elongation and impact strength of the resin while it lowers hardness and tensile strength. On the other hand, the resin increases the tensile strength and hardness and, in general, reinforces the rubber.

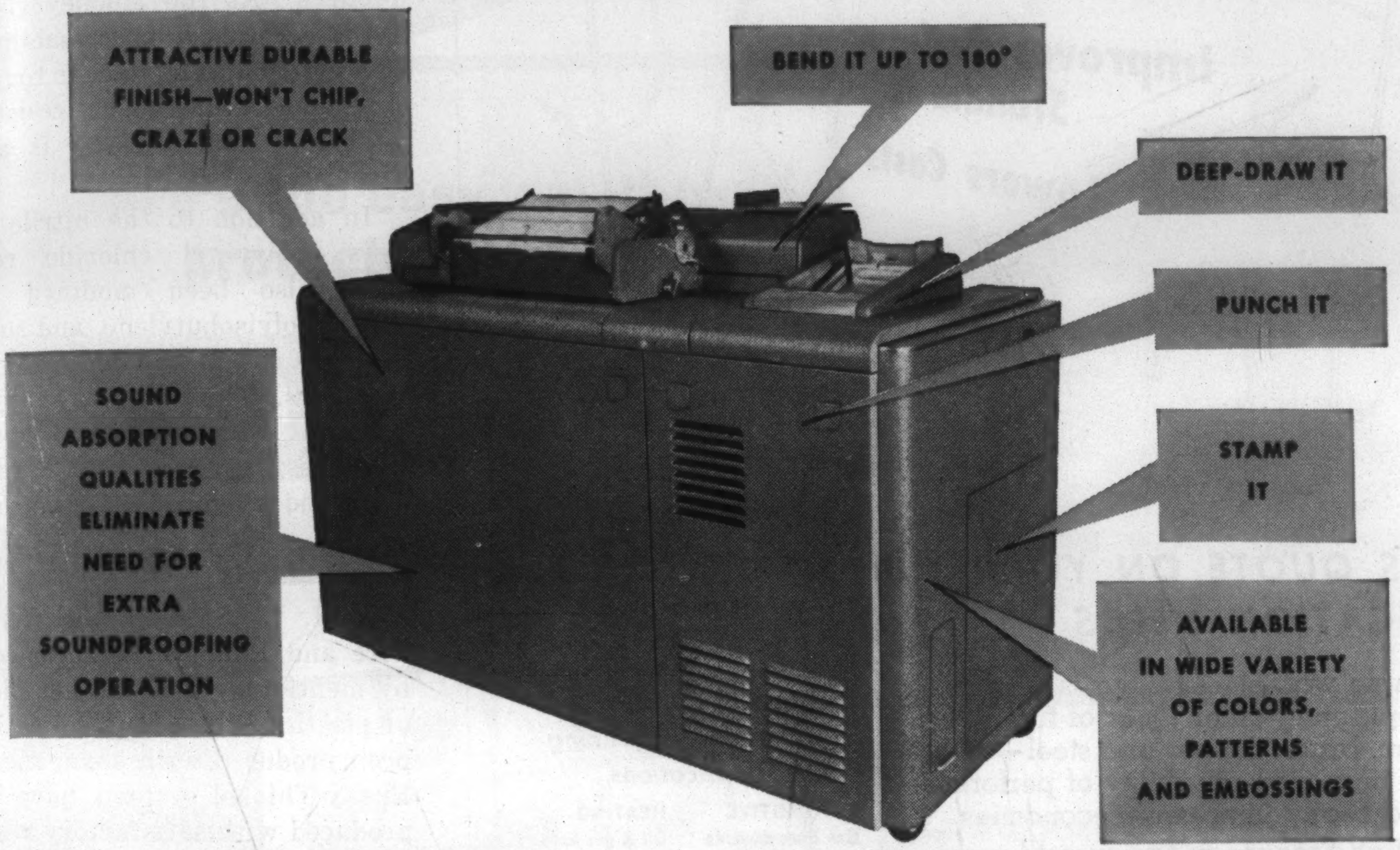
Adhesives made from nitrile rubbers and phenolics adhere to almost all materials except polyethylene, butyl and natural rubber. Molded parts use relatively small amounts of nitrile rubber to produce products which are hard, yet tough; strong yet not brittle. The material is used for three major reasons: 1) thin sheets can be cured and parts punched without fracture; 2) large, complicated inserts can be molded-in without danger of cracking from thermal expansion or contraction and 3) high impact strength can be achieved using fillers which are normally considered to be of low impact strength in conventional compounds.

Polyvinyl chloride and rubber

Acrylonitrile-butadiene copolymers, or N-rubbers, are the most commonly used elastomers for plasticizing or softening polyvinyl chloride polymers and copolymers, according to W. J. Smith of Firestone Tire and Rubber Co. N-rubbers can be prepared with varying amounts of acrylonitrile, with different Mooney viscosities, with different modifiers, and in varying physical form, all of which have a large bearing on resultant physical properties. The blends are characterized by excellent retention of flexibility and impact resistance after prolonged contact with oils, greases and aliphatic hydrocarbons in general, or prolonged exposures to elevated temperatures. Less desirable characteristics include relatively poor resistance to light-aging, a low plasticizing efficiency of N-rubber as compared with that of most liquid platicizers and knotty processing problems.

Generally, as the acrylonitrile

Sullvyne-Clad Metal Laminate Chosen by IBM for Improved Appearance and Virtually Indestructible Finish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SOUND ABSORPTION QUALITIES ELIMINATE NEED FOR EXTRA SOUNDPROOFING OPERATION
AVAILABLE IN WIDE VARIETY OF COLORS, PATTERNS AND EMBOSSINGS

The IBM type 407 Accounting Machine, one of the many IBM machines now covered with Sullvyne-Clad, illustrates several production advantages of this new pre-finished material.

Actual photograph of Sullvyne-Clad sheets in Blonde Mahogany and Buffalo Grain, Coffee Brown.

O'Sullivan

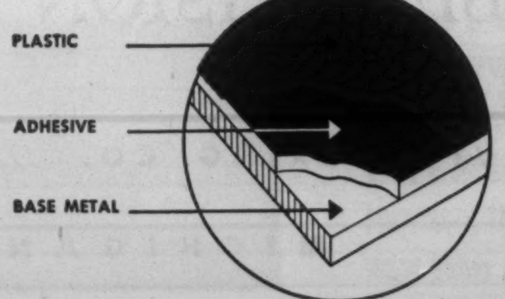
Sullvyne-Clad
Metal Laminate

SULLVYNE-CLAD is a pre-finished sheet made to your specifications with smooth or embossed vinyl sheeting laminated on steel, aluminum or magnesium. Sizes up to 52" x 120".

Sullvyne-Clad is completely flexible, ready for your production line. Process it with your standard tools. Stamp it, punch it, crimp it, deep-draw it, or bend it 180° without damaging the vinyl or breaking the bond.

No special dies or drawing compounds are necessary. Bond strength will vary according to the metal used and the thickness of the vinyl—the average is 35 lbs. per inch.

Sullvyne-Clad slashes service costs; gives you a finish many times thicker than any conventional coating—.012" to .030". It has positive resistance to abrasion and corrosion; won't chip, crack or craze; far superior to ordinary paint, lacquer or enamel.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Improves Performance Standards
Lowers Costs

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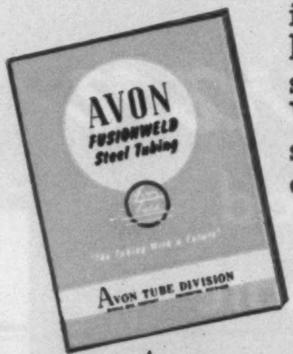
Avon's High Frequency Fusionweld process insures a much higher degree of tensile strength, greater resistance to vibration and fatigue, extreme ductility, plus greatly improved adaptability in producing the most critical tube forms—such as beading, bending, coiling, flaring, knurling, slotting, piercing, threading and swaging without cracking, tearing or checking.

Avon engineers can assist with your tubing problems and help point up cost saving advantages. Why not write, or submit blueprints for quotations.



3/16" O.D. to 3/4" O.D.
PLAIN OR TERNE COATED

A few of the hundreds of Fusionweld Tubing applications

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- Brake lines
- Hydraulic window & seat lifts
- Chassis tubes
- Radiator overflow
- Choke controls
- Oil return lines
- Dip stick tubes
- Oiler tubes
- Automatic transmission

FARM EQUIPMENT
- Hydraulic lifting devices
- Support tubes
- Lubrication lines
- Fuel lines
- Fuel manifolds

ELECTRICAL
- Ceiling & wall fixtures
- Lamp tubes
- Heating elements
- Radio & TV antennae

HEATING
- Oil & gas lines
- Pilot tubes
- Flash tubes
- Pot burner tubes
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- Spacers
- Pop guns
- Bicycle parts
- Mechanical toys
- Tables
- Chairs
- Swings
- Baby carriages, cribs, car seats and beds

MISCELLANEOUS
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- Conveyor oil lines
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- Hose reels

AVON TUBE DIVISION

HIGBIE MANUFACTURING CO.

ROCHESTER MICHIGAN

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Contents Noted

content is increased, grease and oil resistance of the blend is improved, tensile strength increases, processability is improved, product surface is smoother, low temperature impact is poorer, resilience decreases and blocking is reduced. As the Mooney viscosity is increased, processability is poorer, product surface is rougher, low temperature impact resistance is better and blocking is again reduced.

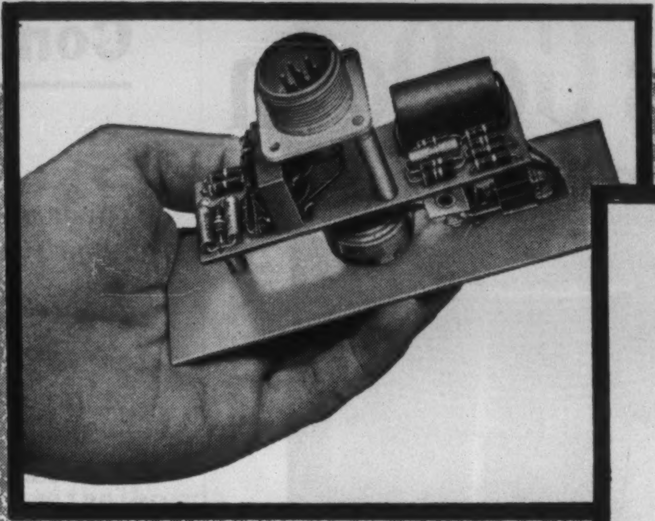
In addition to the nitrile rubbers, polyvinyl chloride resins have also been modified with GR-S, polyisobutylene, and substituted acrylonitrile-butadiene copolymers. They provide many interesting variations in toughness, hardness, impact resistance, abrasion and chemical resistance.

Other blends

A. J. Urbanic of the General Tire and Rubber Co. summed up by mentioning a few other blends of plastics and rubber which have been produced with some success. Epoxy-Thiokol systems have been produced with satisfactory results in improving the toughness of epoxy adhesives. Neoprene-styrene blends give a tough, high-heat distortion material which has high impact strength at temperatures as low as -4 F. Ethyl cellulose blended with natural rubber produces a softer composition with increased elongation at break. Mixed with GR-S, ethyl cellulose obtains improved dimensional stability and increased resistance to flex cut growth.

Importance of Metals' Substructure Stressed

The effect of substructure on the physical properties of metals has often been overlooked. Substructure is the structure within grains or single crystals of metals. Generally a polycrystalline piece of pure metal is thought to be made up of an aggregate of grains and that these grains are nearly perfect crystalline arrays of atoms. In single crystals where there are no interfering grain



this control needed protection

here's the easy way they protected it with

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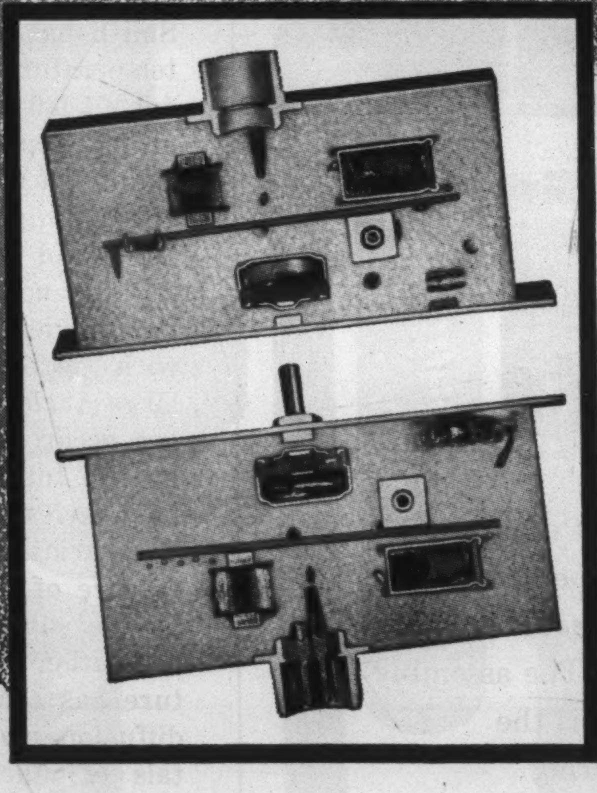

result: a complete barrier against vibration, corrosion, dampness, fungi

Hamilton Standard Division, United Aircraft Corporation, needed a potting material for the electronic temperature control unit that governs cockpit air-conditioning—found Nopco Lockfoam ideal for the purpose.

Nopco Lockfoam is indeed ideal for this and many other similar tasks because of the absolute protection it affords against damage from severe vibration. Its light-weight closed-cell structure makes a tamper-proof assembly, and gives a high impermeability to dampness, corrosion, and fungi growth. Also, its pour-in-place technique effects great economy of assembly time.

Further, each of the 50 different formulations available is highly consistent and reproducible.

Perhaps the rare combination of properties of this versatile plastic can help with some product *you* have in mind. *Write today for the Nopco Lockfoam booklet.*

Where Can YOU Best Use These Properties?

Near-perfect Radar Transmission

Ease of Fabrication
It's "poured-in-place"

Great Strength with Light Weight

Excellent Electrical Properties
6 lb/cu ft Lockfoam tested at 9.375 KMC
Dielectric Constant 1.05
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.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

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Preparation of parts for assembly of a unit equipped with bearings and the actual assembling operations often add serious costs which can be eliminated by the use of Bunting Cast Bronze Bearings. The assembly of a unit equipped with Bunting Bearings is the simplest, easiest and most economical bearing assembly possible.

It will pay you to investigate the cost reductions made possible by the use of Bunting Cast Bronze bearings in your product. There is a Bunting engineer near you for consultation, or write our Product Engineering Department at Toledo.

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boundaries, the regularity of the atomic arrays is considered to be uninterrupted throughout the specimen. The regularity, of course, has slight imperfections due to the presence of impurity atoms, vacancies, or dislocations. These basic factors are pointed out by R. L. Smith, of the Solid State Physics Div. of the Franklin Institute in last November's issue of the *Journal of the Franklin Institute*. Dr. Smith goes on to emphasize how substructures can affect physical properties of metals.

Veining in ferritic steel or a regular closed pattern such as shown in aluminum and zinc in the sub-grain structure can have considerable effect on physical properties of the metals, particularly at low temperatures. Dr. Smith has shown that at normal temperatures a low carbon alloy (about 0.04% or less) has a yield strength primarily dependent on grain size. The smaller the grain size the higher the yield strength. At liquid air temperatures this relation no longer holds true, although yield strength will increase with decreasing grain size. A large variation in yield strength can occur at constant grain sizes by the introduction of sub-grain boundaries manifested by veining. The variation may be due to interference of dislocation movements by the sub-grain boundaries.

Another area where substructure has considerable effect is in diffusion results. In single crystals of zinc a substructure appears which can only be revealed by etching, since the disregistry is only a matter of a few seconds of arc. This structure results in anomalous self-diffusion values, and at low temperatures grain boundary diffusion becomes more important than volume diffusion. It also seems reasonable to suppose that sub-grain boundaries should act as easy paths for diffusion, according to Dr. Smith.

Further work is being carried out to determine the detailed nature of sub-grain boundary and to evaluate its effect on physical

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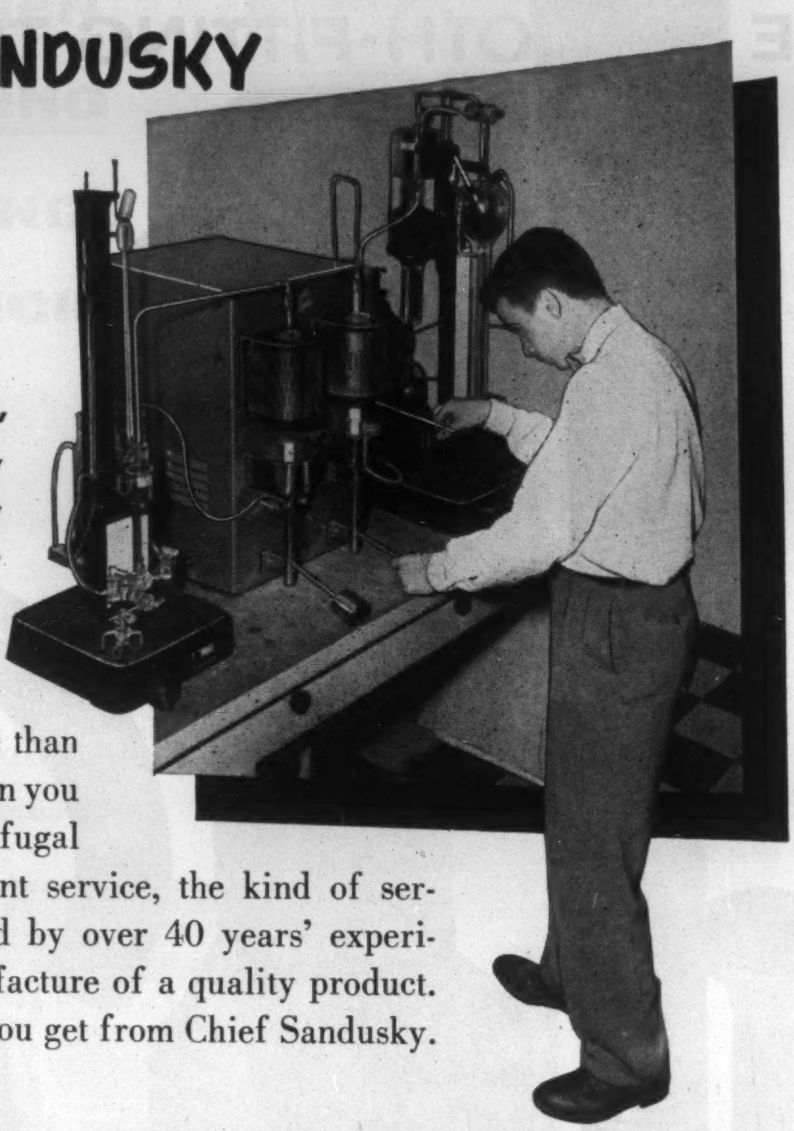

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properties. The presence of substructures should always be looked for in metallurgic experiments and their possible effect should be considered.

Avoid Corrosion by Using Inhibitors

Use of inhibitors is one of the simplest ways of overcoming corrosion. When the action of inhibitors is understood, selection of the proper one becomes simple. In last January's issue of *Werkstoffe und Korrosion* (German), H. Fischer classifies corrosion inhibitors as physical inhibitors, which block the metal from corrosion by physical adsorption on the surface, and chemical inhibitors, which react either with the metal surface to be protected or with the aggressive constituents of the corrosive medium. Physical inhibitors are sufficient to stop the discharge of ions, which is one step in some types of corrosion, e.g., corrosion with evolution of hydrogen. Chemical inhibitors are necessary to suppress passage of electrons from the metal to the ions of the corrosive medium, e.g., corrosion involving consumption of oxygen.

Chemical inhibitors in turn can be divided into 4 groups: 1) passivators, 2) formers of protective coatings, 3) electrochemical inhibitors, and 4) de-stimulators. The first three act on the metal surface, the fourth on the corrosive medium. Passivators and formers of protective coatings are frequently used commercially, but the last two types are still relatively uncommon.

Inhibitor selection

Corrosion with evolution of hydrogen occurs mainly in acid solutions and can be blocked by physical or electrochemical inhibitors. Hydrogen evolution can also accompany corrosion in alkaline solutions with zinc and aluminum. In such cases physical inhibitors are favored. Passivators and formers of protective coatings are dominant in prevention of oxygen-

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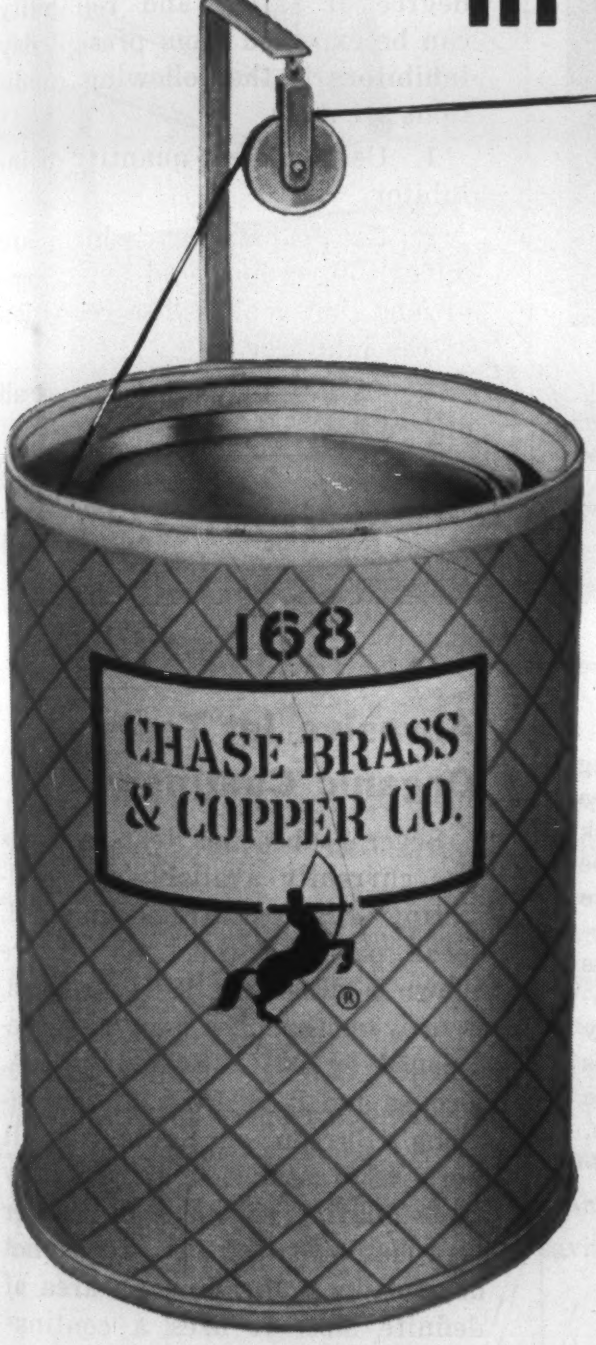

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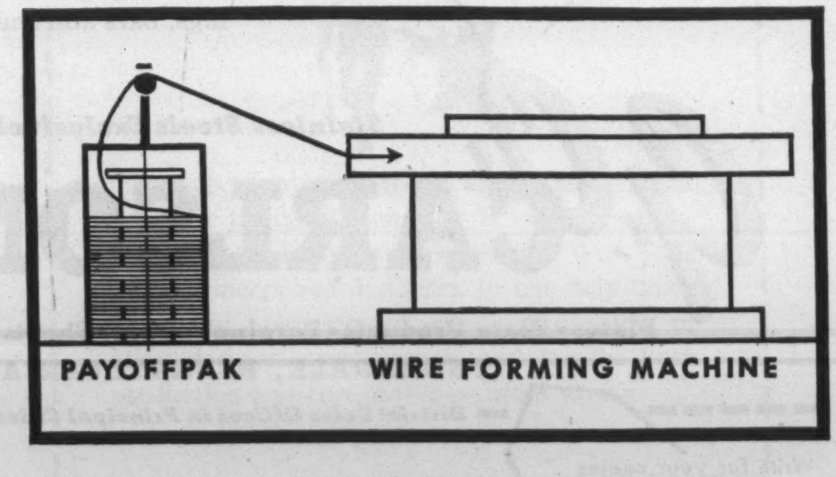
Ask your Chase Wholesaler or nearest Chase Warehouse about the new Payoffpak the next time you order copper alloy wire.



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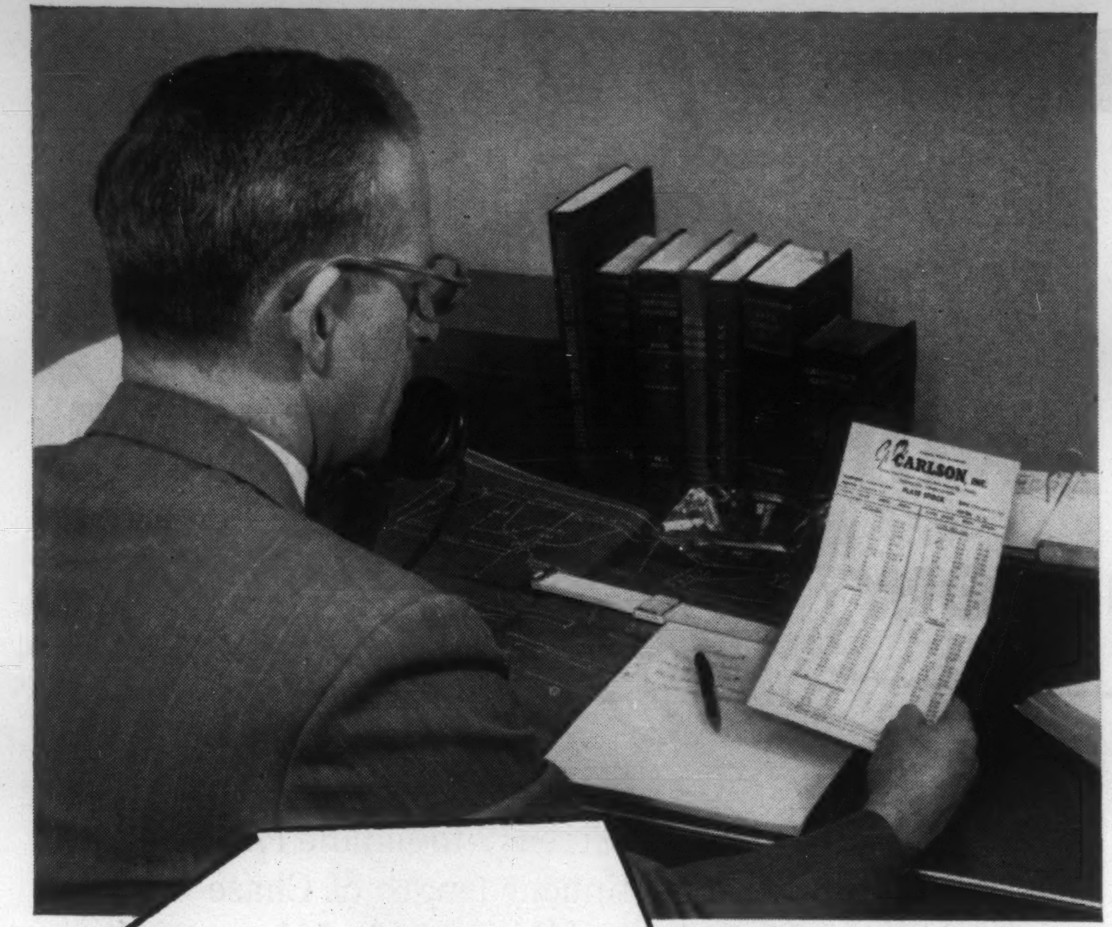

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consuming corrosion, which generally takes place in neutral solutions. Either formers of protective coatings or physical inhibitors can be used in alkaline solutions, depending on the type of corrosion. A new field of use for inhibitors which is rapidly becoming important is the inhibition of gaseous corrosion with gaseous inhibitors.

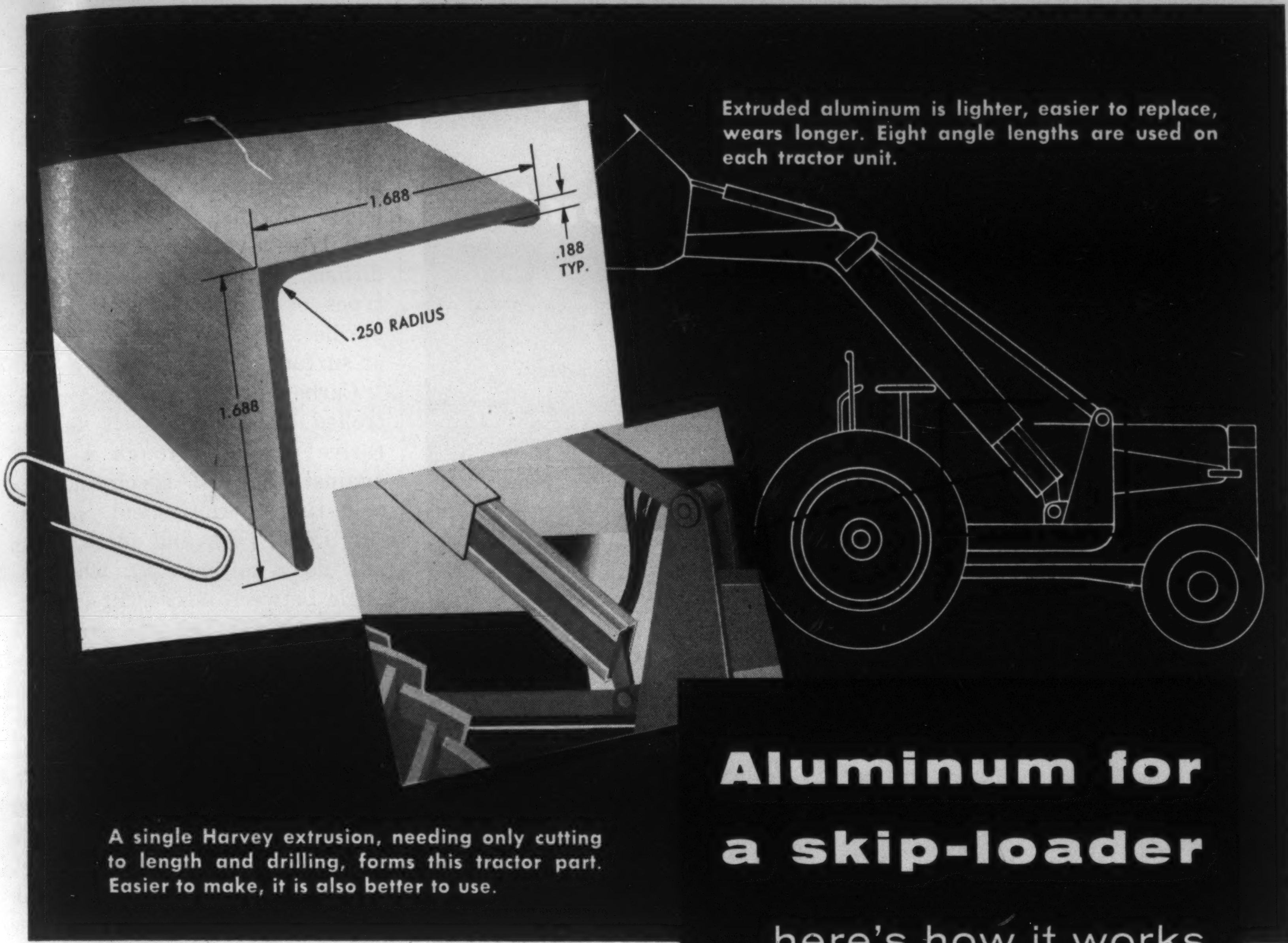
The author claims that a high degree of safety and reliability can be expected from present day inhibitors if the following conditions are met:

1. Use sufficient quantity of inhibitor.
2. Use substances which are difficult to reduce and avoid conditions that could cause reduction of the inhibitor.
3. Take into consideration all different metals involved.
4. Be sure the inhibitor is suited to the corrosive conditions at the finish as well as at the start of service.

Abrasive Jet Tests Organic Coatings

Several abrasion test methods are currently available for evaluating organic coatings. In effect, loose particles fall, rub or are blown against the test specimen. A new method has now been developed by A. G. Roberts, W. A. Crouse and R. S. Pizer of the National Bureau of Standards. It permits greater ease and rapidity in evaluating coatings and better reproducibility since it does not depend upon abrading an area of definite size. It uses a continuously fresh supply of abrasive particles under closely controlled conditions. The method is described in a summary Technical Report issued in January by the NBS.

Essentially, the method determines the time required for a high-speed jet of fine abrasive particles to abrade through the coating to the base material. The end point is the first show of bare metal and is readily detected



Extruded aluminum is lighter, easier to replace, wears longer. Eight angle lengths are used on each tractor unit.

A single Harvey extrusion, needing only cutting to length and drilling, forms this tractor part. Easier to make, it is also better to use.

Aluminum for a skip-loader

. . . here's how it works

Construction men demand two qualities in their equipment. First, it must be rugged. Second, replacements must be held to a minimum.

Harvey aluminum extrusions help build both of these qualities into a well-known line of tractor accessories . . . more effectively and at lower cost than with materials formerly used. Most critical point in the basic unit is the telescoping tension arm supporting various attachments. The wear plates under the sliding arms had been a constant source of trouble. Brass proved too heavy, too costly. Then aluminum sheet, bent and heat-treated, was tried . . . some saving, but still too costly because of complex fabrication and excessive scrap.

A Harvey Field Engineer suggested changing to a single Harvey Extrusion, made of Harvey Alloy 6066, in the exact cross section needed. The result: (1) an easier product to make, saving 42¢ per wear plate; (2) a better product to sell . . . plates are lighter, easier to replace and wear longer.

For your aluminum needs, call a Harvey Field Engineer today. His one job is to put *custom-designed* aluminum to work for you. With your own engineers and designers, he can help tailor aluminum extrusions to *your* requirements of alloy, temper, cross section and length. Both production and cost problems often vanish.

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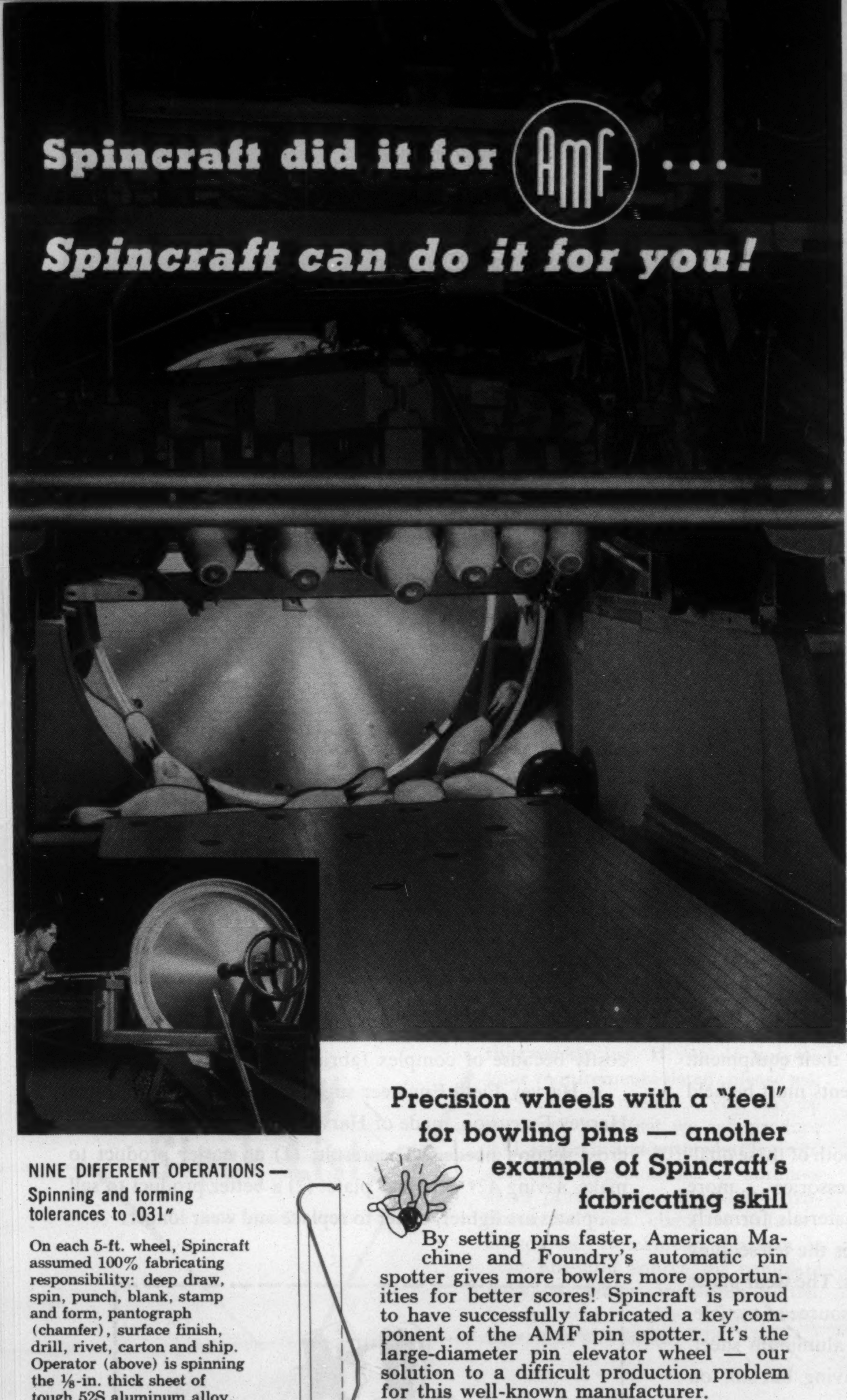

Precision wheels with a "feel" for bowling pins — another example of Spincraft's fabricating skill

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On each 5-ft. wheel, Spincraft assumed 100% fabricating responsibility: deep draw, spin, punch, blank, stamp and form, pantograph (chamfer), surface finish, drill, rivet, carton and ship. Operator (above) is spinning the ⅛-in. thick sheet of tough 52S aluminum alloy. Cross-section of basic wheel (right) shows unusual contour requirements. Raised segments are ⅛-in. cold rolled steel.

Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

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when coating and base metal differ in color, or may be determined by inspection with a hand lens. Because the instrument simulates a variety of service conditions, it may be used on all types of protective coatings, regardless of gloss, color, thickness, or surface area.

Carbon dioxide gas under controlled pressure propels the abrasive powder through a nozzle against the test specimen. The mounting arrangement permits rotational, back- and forth, or up and down adjustment, while the angle between nozzle tip and surface is adjustable by a graduated rotating disk attached to the nozzle shaft. A calibrated taper gage permits adjustment of nozzle-to-specimen distance at abrading angles from 20 to 90 deg. Flow of abrasive is started and stopped by a manually operated solenoid valve.

Though operating condition can be varied to accommodate extreme differences in materials, it is usually desirable to use a nozzle-coating distance of 0.04 in., a gas pressure of 40 psi, a flow rate of approximately 0.15 gm per sec, and abrading angles of 90 or 45 deg. The 90-deg angle simulates leading-edge type of erosion encountered by aircraft in flight, while the 45-deg angle simulates scuffing wear received by aircraft during maintenance operations.

Abrasion time for a given material depends on test conditions. It increases almost linearly with increasing nozzle-to-coating distance, decreases with increasing pressure and decreases with decreasing angle of abrasion down to about 30 deg. At smaller abrading angles, abrasion time rises again.

Permanent Magnets Used for Mechanical Applications

Until recently, permanent magnets were used almost exclusively in the electrical field. Lately, however, there have been increasing

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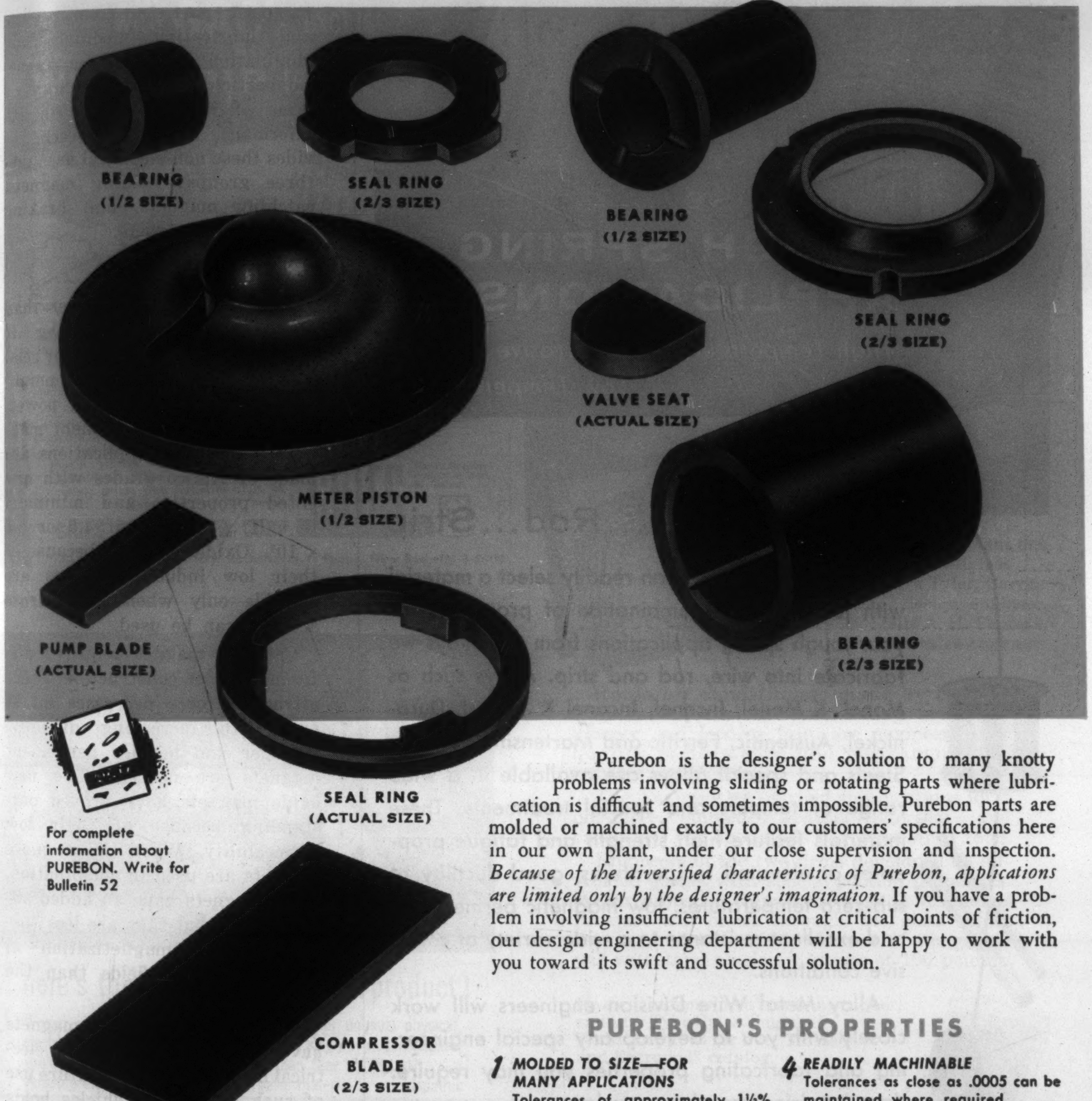
Carbon-graphite especially designed for mechanical applications.


BEARING (1/2 SIZE)
SEAL RING (2/3 SIZE)
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applications of permanent magnets for purely mechanical reasons such as couplings, holding mechanisms to replace mechanical fasteners, brakes, removal of fine magnetic particles from cooling and lubricating mediums and elimination of extraneous magnetic particles. In last February's issue of *Werkstatt und Betrieb* (German), H. Fahlenbrach divides these non-electrical uses into three groups: holding magnets, catching magnets, and braking or damping magnets.

Selection of magnets

Use of permanent rather than electromagnets for holding is generally economical only for relatively light loads, in the neighborhood of 220-lb lifting power. The majority of permanent magnets for holding applications are made of Alnico grades with oriented properties and minimum $B \cdot H_{max}$ values of 4.5 or 5.5 x 10^6. Oxide magnets, because of their low induction values are suitable only when large cross sections can be used.

Catching magnets require a different type of construction. Since attractive force decreases markedly with increasing distance, stronger and heavier permanent magnets are needed. The new oxide magnets have proved outstanding because of their low permeability. When two or more magnets are used in combination, oxide magnets have an added advantage in that they are less susceptible to demagnetization in strong magnetic fields than the Alnicos.

Braking or damping magnets have been widely used in the electrical field on counters. Future use of such brakes on vehicles holds possibilities of increased operating safety with lower wear than present braking mechanisms. Braking action is caused by eddy currents produced in parts with high electrical conductivity. Eddy currents have a magnetic field opposed to that of the permanent magnet, so the final braking is due to pure magnetic repulsion. Best results have been obtained

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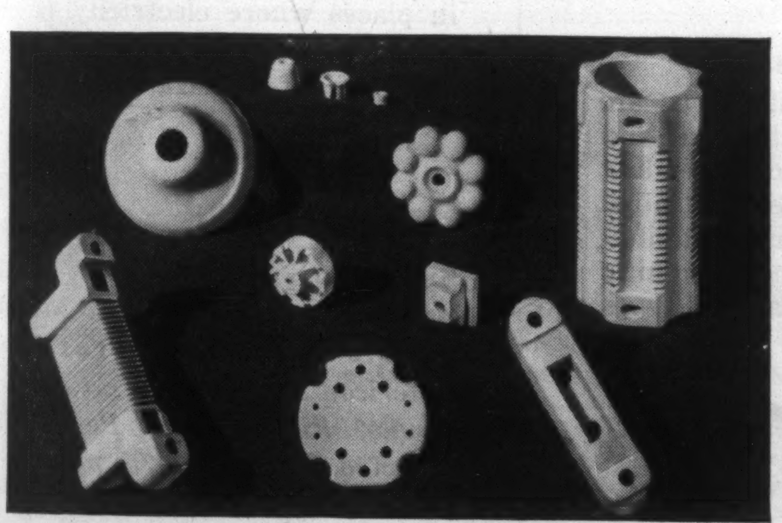

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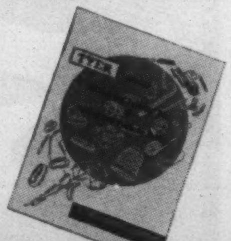

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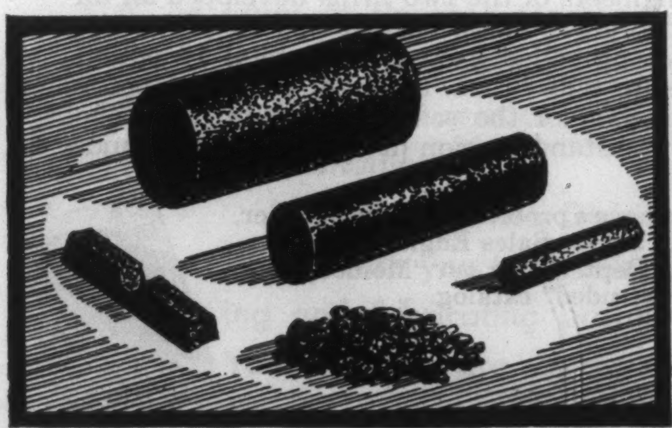

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Contents Noted

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Books . . .

Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures. *American Society for Testing Materials, Philadelphia, Pa., 1955. Paper 6 by 9 in. 175 pp. Price $3.00.*

This symposium was sponsored by the ASTM-ASME Joint Committee on the effect of temperatures on metals. Eight papers are included. Two cover theoretical considerations including creep under intermittent load and cyclic thermal stresses. Three deal with creep and stress rupture data for wrought high temperature alloys in bar and rod form, while the last two deal with various ferrous and nonferrous alloys in sheet form. Discussion of the papers is included.

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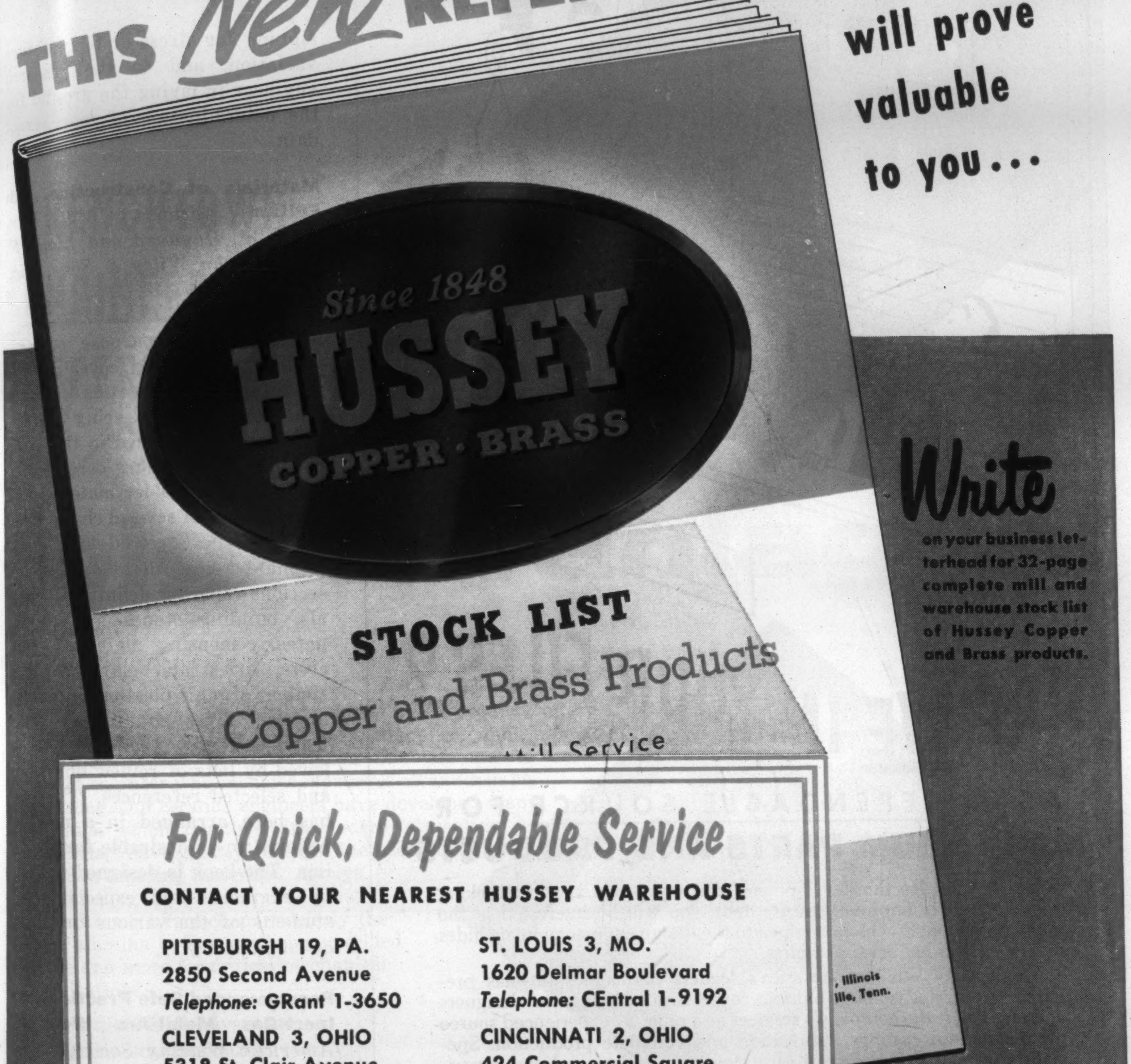
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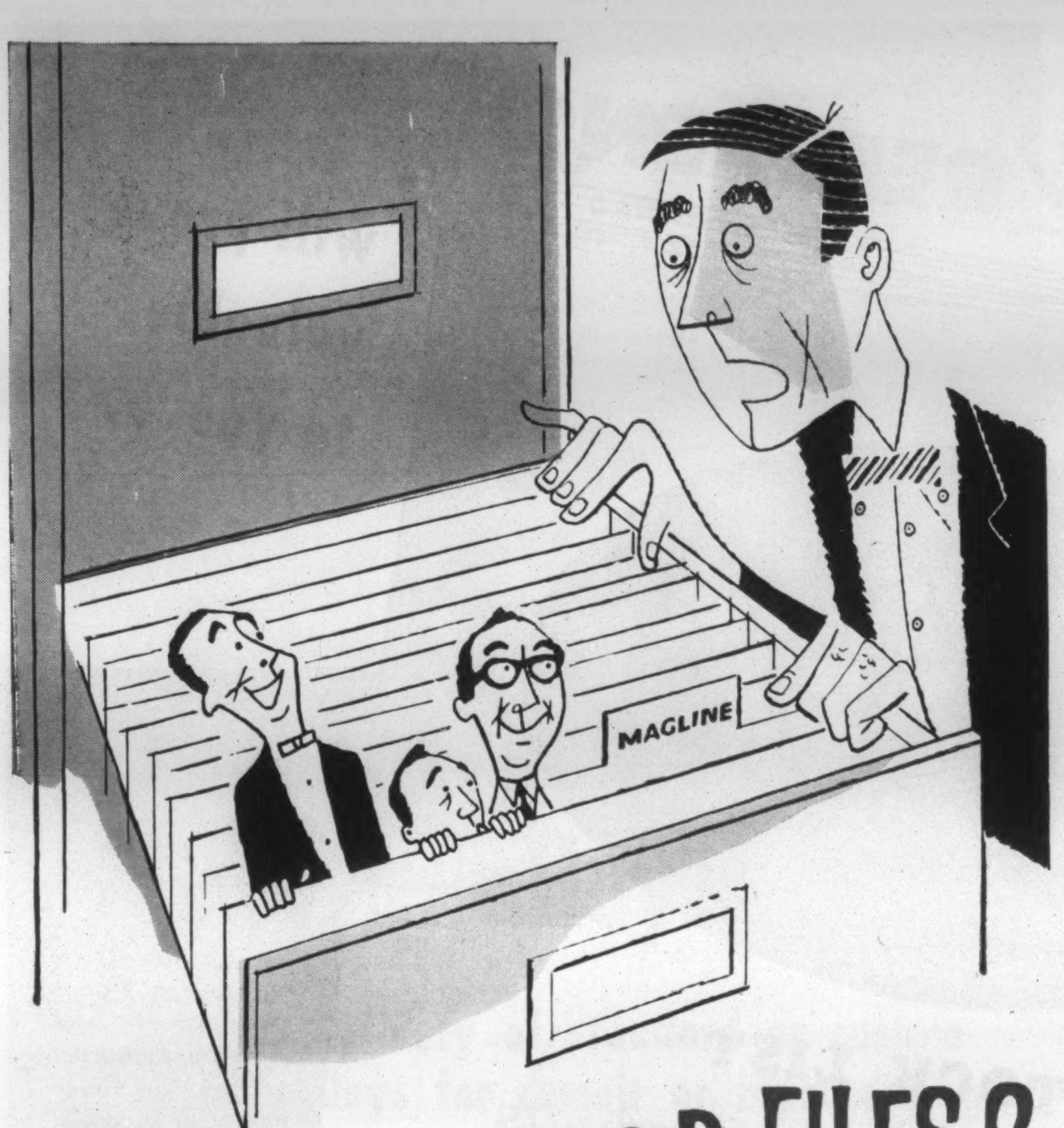

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Contents Noted

Books . . .

signing for stress or temperature variation, and to the research engineer in laying the ground for the determination of more exact data.

Materials of Construction, 6th Edition. *Adelbert P. Mills, Harrison W. Hayward and Lloyd F. Rader. John Wiley & Sons, Inc., New York, N. Y., 1955. Cloth 6 by 9 in. 650 pp. Price $7.50.*

The original purpose of providing a textbook covering the manufacture, properties and applications of engineering materials has been retained in the sixth edition. The changes consist of a revision of the older material and the addition of several chapters on materials not covered previously.

The book is divided into ten sections covering definitions, metals, building stones and aggregates, cementing materials, concrete, brick and clay products, timber, organic plastics, laminates and adhesives and organic protective coatings. Chapters are followed by lists of review questions and selected references. The text has been arranged in a manner believed to be desirable for teaching. The book is designed for use by engineers and especially for students of the various branches of engineering.

Recommended Safe Practices for Inert-Gas Metal-Arc Welding. *American Welding Society, New York 18, N. Y., 1955. Paper 6 by 9 in. 5 pp. Price $.50.*

The safety recommendations covered in this report are based on laboratory studies, industrial experience and an extensive review of the literature. All known potential hazards peculiar to the inert-gas metal-arc process are covered. It was concluded that no significant hazards exist from either ozone or nitrogen oxide, and there is no dangerous quantity of radioactivity emitted by thoriated-tungsten electrodes.

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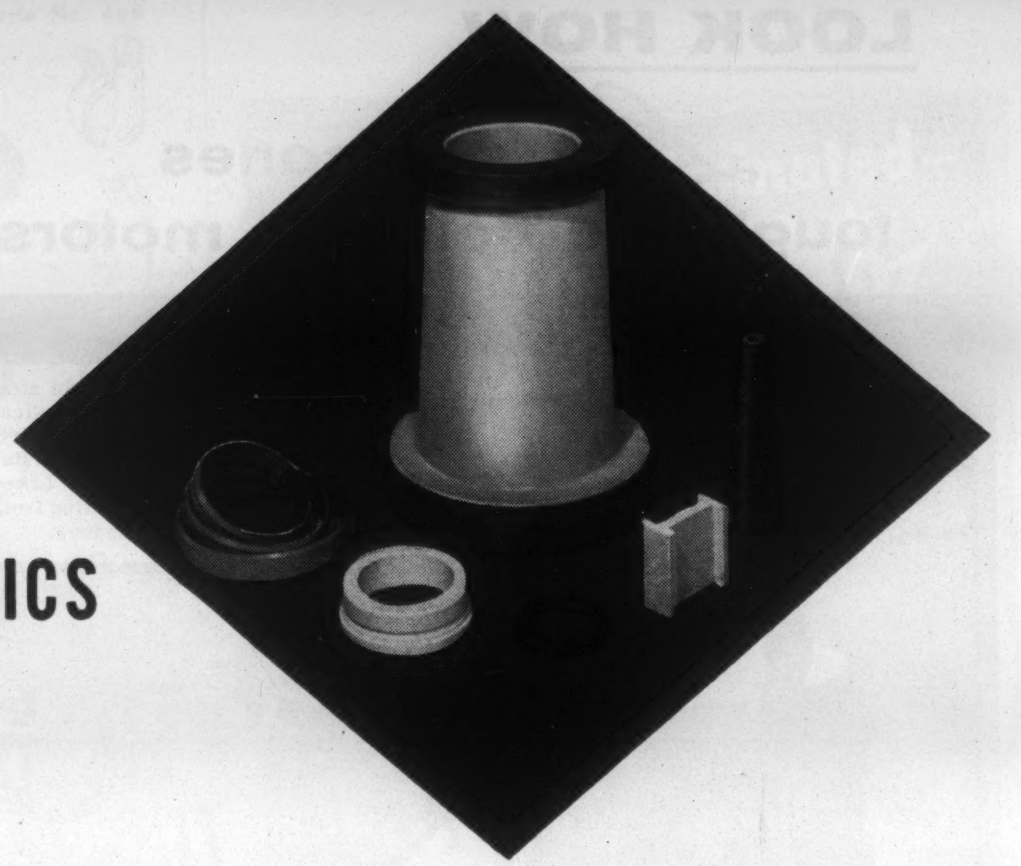

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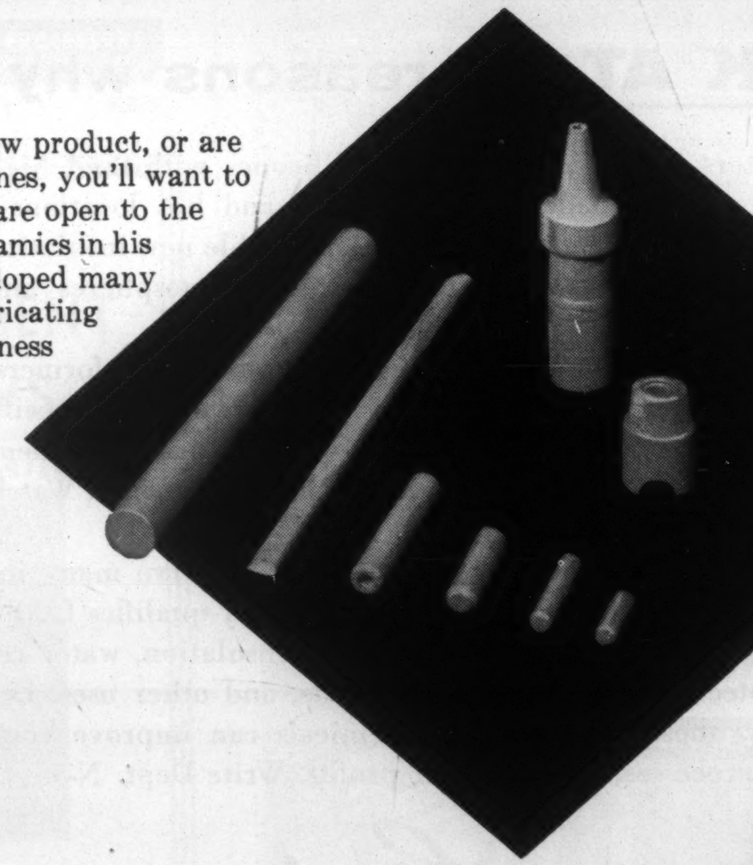

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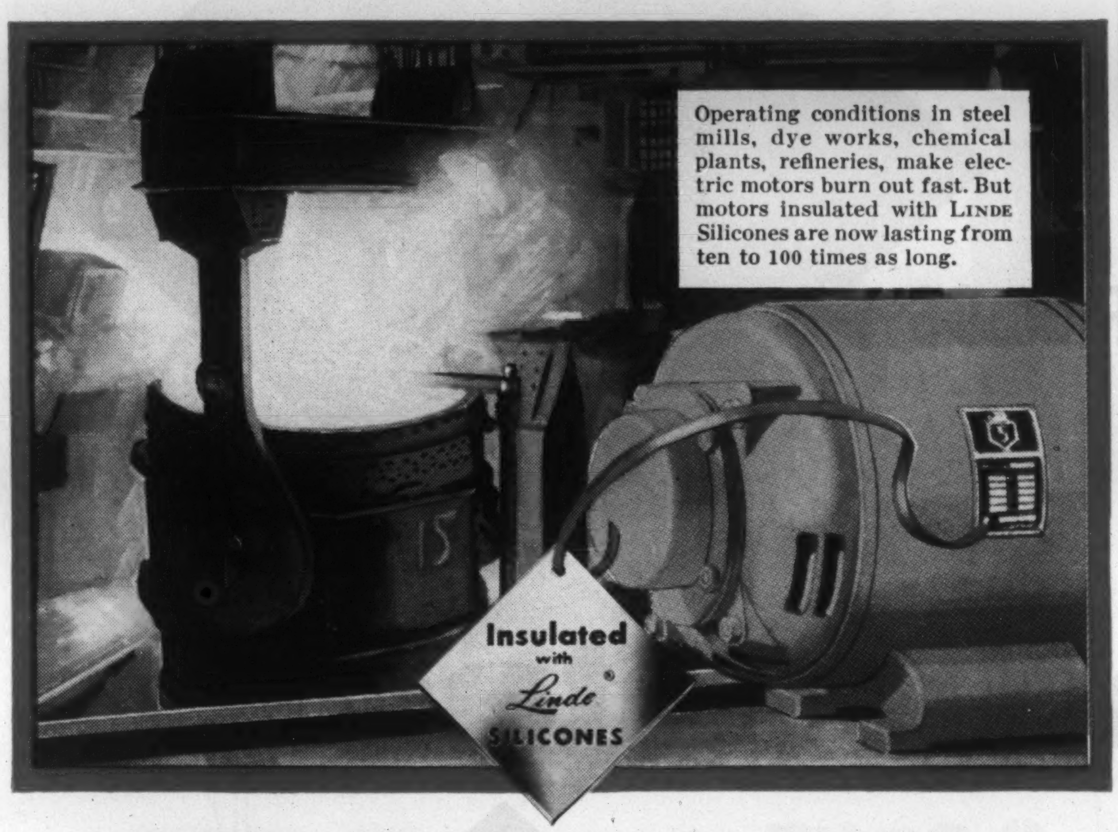

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Contents Noted

Books . . .

welding operations. Deposition of the vapor of this chemical by radiation from the welding arc produces fumes including phosgene.

The publication outlines adequate control measures for protecting workers from ultraviolet radiation and metal fumes produced during the welding process.

A List Of American Standards-1955. *American Standards Association. New York 17, N. Y. Paper 8½ by 11 in. 48 pp. Free on request.*

This publication lists and indexes about 1500 American Standards. Included are 210 for civil and constructional engineering, 153 mechanical, 272 electrical, 62 metallurgical, 69 chemical and 11 rubber. Information is given also on the procedure for purchasing the standards.

Bibliography of Industrial Radiology 1952-1954. *Herbert R. Isenburger, St. John X-ray Laboratory, Califon, N. J., 1955. Paper 8½ by 11 in. 24 pp. Price $3.00.*

This bibliography, the fifth supplement to INDUSTRIAL RADIOLOGY, published about 12 years ago, contains more than 900 references to articles on the subject which have appeared during the period covered.

The Strain Gage Primer. *C. C. Perry and H. R. Lissner, McGraw-Hill Book Co., 1955. Cloth 6 by 9 in. 281 pp. Price $6.00.*

This book is a guide to the best methods of using strain gages for accurate results. It covers experimental stress analysis with particular emphasis on bonded wire strain gages. Included also is a section on an important application of the strain gage as a transducer element for instrumenting and controlling various mechanical variables such as form, torque, speed and pressure.

Tentative Specification for Mild Steel Arc-Welding Electrodes A233-55T. *American Welding*

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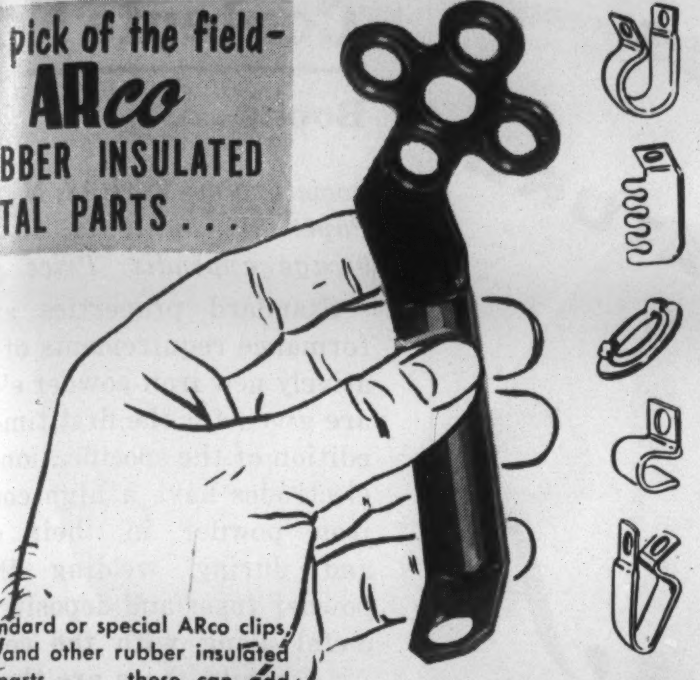

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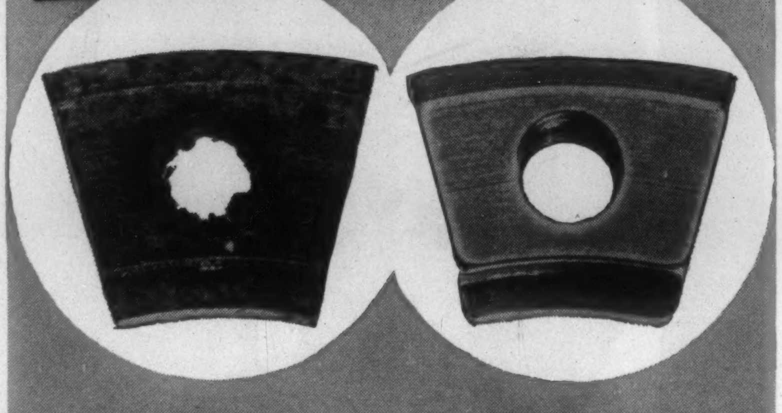

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Contents Noted

Books . . .

Society, New York 18, N. Y., 1955. Paper 8½ by 11 in. 15 pp. and 9-page appendix. Price $.40.

Standard properties and performance requirements of the relatively new iron powder electrodes are given for the first time in this edition of the specifications. These electrodes have a high content of iron powder in their coatings and during welding the iron powder fuses and deposits as weld metal along with the core wire. As a result, these are the highest deposit rate manual electrodes produced. An appendix contains complete details on the iron powder electrodes including voltage and current ranges, description of the welds produced and properties to be expected.

The specification covers also other standard lightly coated and covered metal arc welding electrodes.

Deep Drawing. *J. Willis. Butterworth Scientific Publications, London, England. 1954. Cloth 5½ by 8½ in. 134 pp. Price $3.50.*

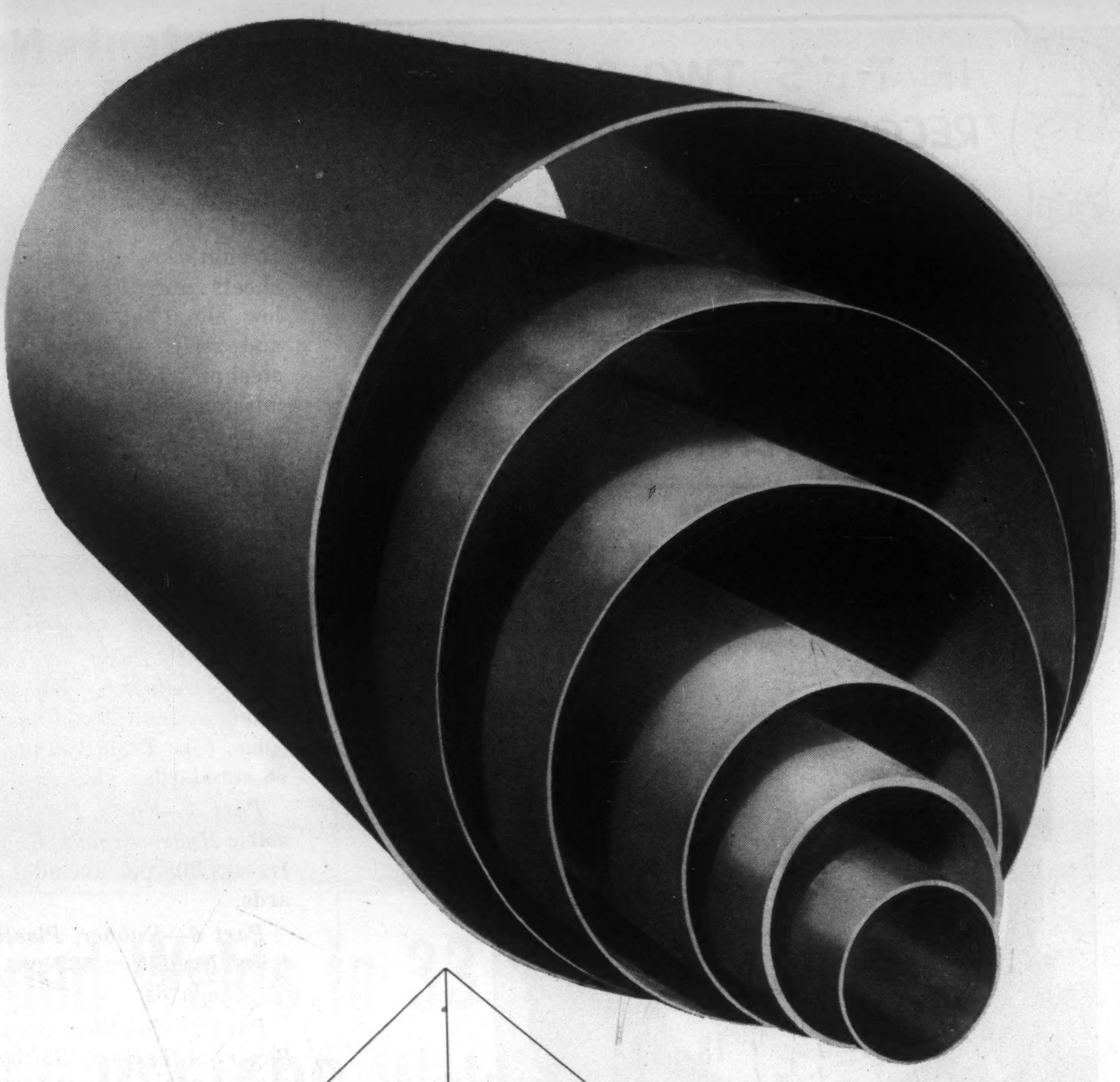
This book is a review of the practical aspects of the investigations of H. W. Swift on the underlying principles of deep drawing. It is based on 16 years research in a field in which Professor Swift is a leading authority.

Ten chapters cover experimental equipment, development of a theory of deep drawing, single and two stage drawing, ironing, shearing, lubricants, effects of sheet temper and punch profile, simulated tests and applications of research findings to industrial practice.

Engineers engaged in the forming and fabricating of sheet metals will find much thought-provoking information in this book.

1954 Supplements to Book of ASTM Standards. *American Society for Testing Materials, Philadelphia 3. Pa. Paper 6 by 9 in. 7 parts. Price $3.50 per part. $24.50 per set.*

Part 1—Ferrous Metals 608 pp. Includes 89 standards on fer-



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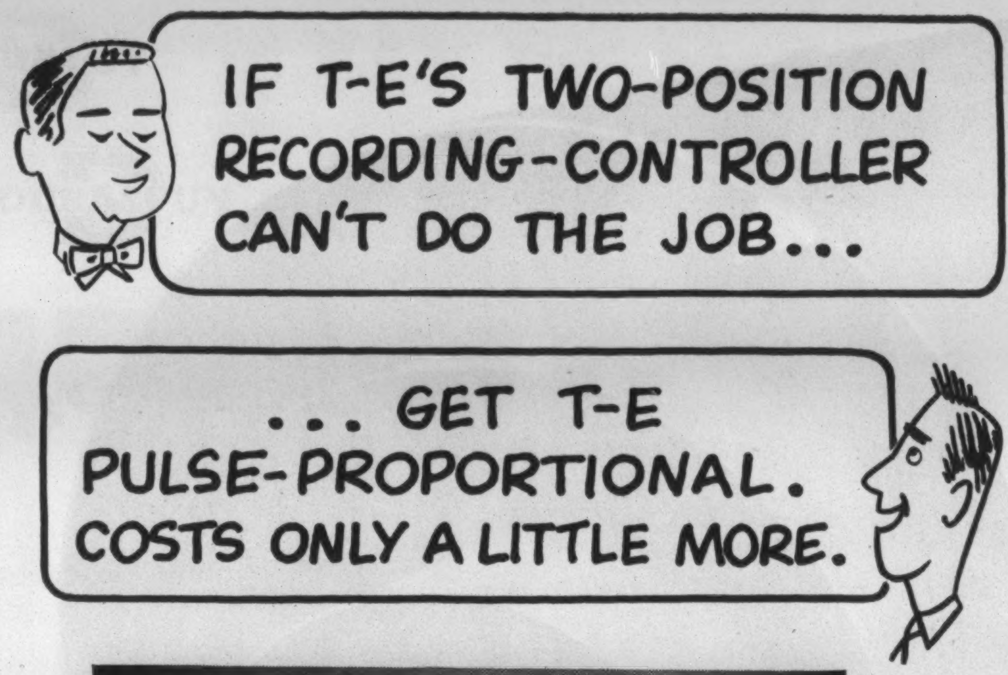
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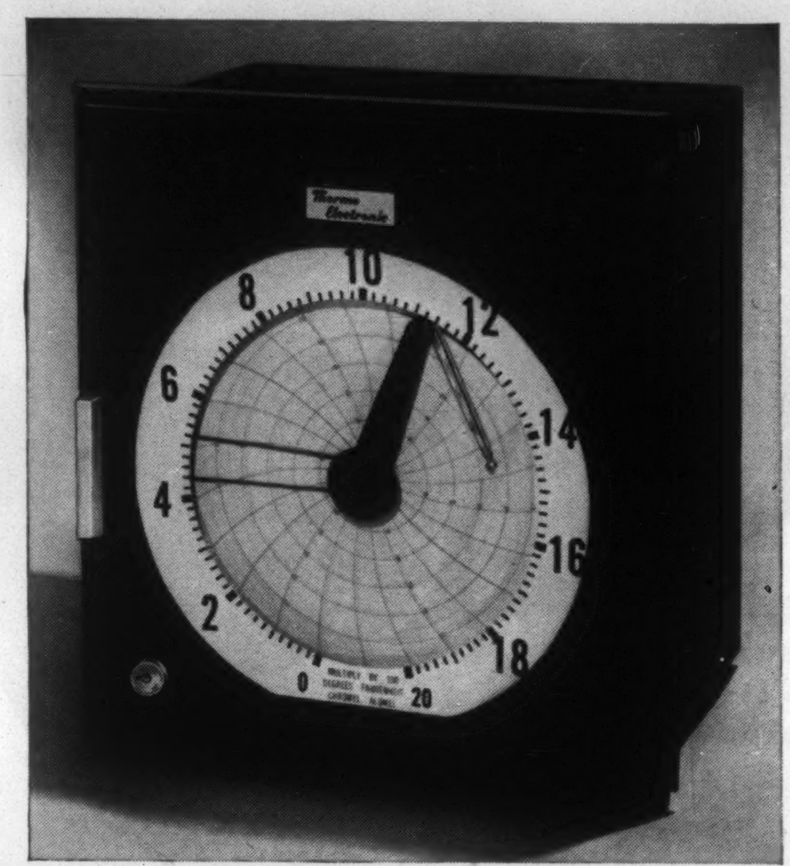

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Contents Noted

Books . . .

rous materials including new tentative designations for structure steel for welding, high strength low alloy cold rolled steel sheets and strip, high strength low alloy hot rolled steel sheets and strip and metal-arc welded steel pipe for high pressure transmission service.

Part 2— Nonferrous Metals 444 pp. Includes 81 standards.

Part 3—Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, Soils 416 pp. Includes 77 standards covering these materials.

Part 4—Paint, Naval Stores, Wood Cellulose, Wax Polishes, Sandwich and Building Constructions, Fire Tests 160 pp. Includes 28 standards.

Part 5—Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes 308 pp. Includes 36 standards.

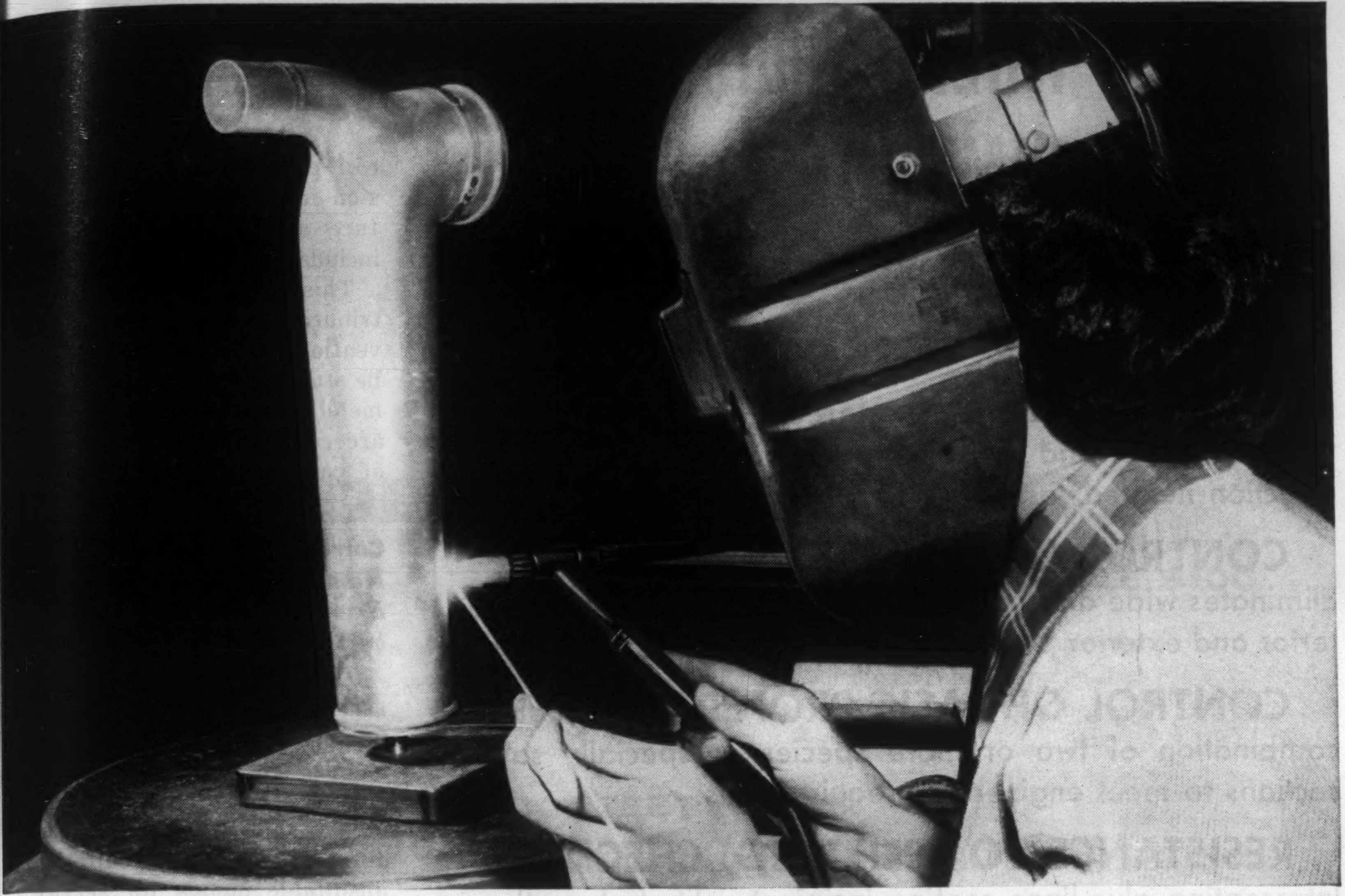
Part 6—Rubber, Plastics, Electrical Insulation 532 pp. Includes 66 standards.

Part 7—Textiles, Soap, Water, Paper, Adhesives, Shipping Containers 296 pp. Includes 38 standards.

Protective Coatings for Metals. *R. M. Burns and W. W. Bradley. Reinhold Publishing Corp., New York 22, N. Y., 1955. Cloth 6 by 9 in 643 pp. Price $12.00.*

This is the second edition of a book which appeared originally about 15 years ago. It has been greatly enlarged and almost completely rewritten to cover the recent developments in metallic and organic coatings.

The book contains 18 chapters. Following a discussion of corrosion control and the preparation of surfaces for coating, 9 chapters are devoted to various metallic coatings including zinc, cadmium, tin, nickel, chromium, and a number of other metals. This section concludes with a chapter on methods of testing metallic coatings. Three chapters are devoted to organic coatings and their properties and other chapters deal with chemical conversion coatings, spe-



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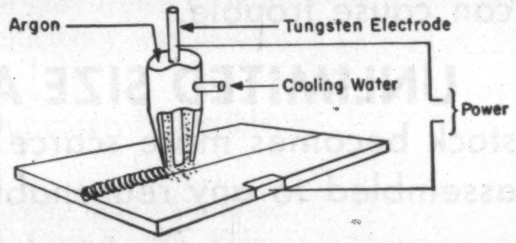

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GAMBLE BROTHERS GUARANTEED BOND
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Contents Noted

Books . . .

cial purpose coatings and corrosion inhibitors. Extensive literature and patent references are included.

This book is an important contribution to the literature on prevention of corrosion and should be studied by corrosion engineers, metallurgists and chemists who are concerned with the problems of corrosion control.

Corrosion Data Survey. *G. A. Nelson, Shell Development Co., Emeryville, Calif. 1954. Cloth 8½ by 11 in. Price $35.00.*

This book summarizes in a series of charts corrosion data on a number of ferrous and nonferrous metals. The data have been compiled from published sources and an attempt has been made to differentiate between suitable and unsuitable metals for service in specific environments. The author points out that the charts should be used as a guide, and suggests that in many cases corrosion tests and pilot plant installations may be required. Since little information on the concentration of the corroding medium and the specific conditions of testing are included, the charts should be considered as a qualitative approach to the subject.

Sixty charts are used to indicate corrosion resistance of a series of 28 metals to a wide variety of chemicals which are listed alphabetically. Separate charts are used to report resistance to sulfuric, hydrochloric and mixed acids and to hydrogen and carbon monoxide at high temperature and pressure.

The corrosion engineer will find this book valuable particularly for eliminating unsuitable materials from consideration. The addition of a cross-index to the chemicals covered would have greatly increased the value of this book.

Reports . . .

Materials Research Program Review of the Air Force Materials Research and Development Pro-

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enter the 1955

GRAY IRON REDESIGN CONTEST

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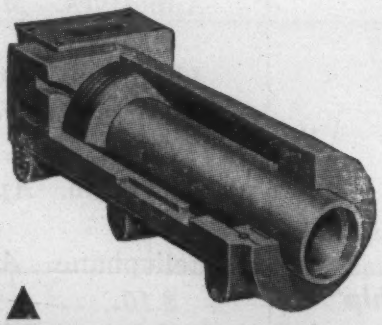
3RD PRIZE $100

Make your redesign ideas pay off in cash! You are eligible if you have redesigned a product or part for production in gray iron which economically and efficiently replaced a competitive material. Regardless of how simple or complex your entry may be, you have a good chance of winning.

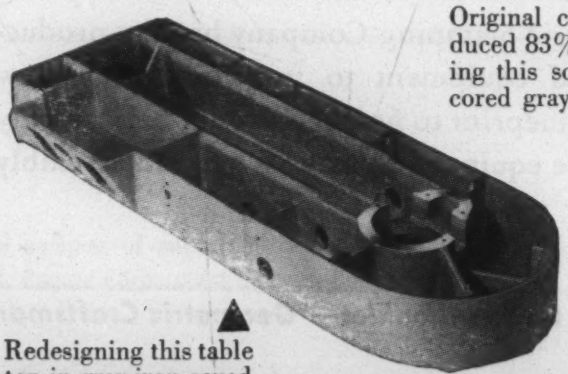
FOLLOW THESE EASY CONTEST RULES

1. Select the best example of products or parts that you have redesigned for production in gray iron.
2. Give all facts leading up to your redesign . . . why you thought of gray iron . . . how much was saved in labor and/or material costs . . . how much efficiency was gained and any other factors leading to your decision.
3. Submit an 8″ x 10″ glossy photo of the gray iron casting with your entry. If possible, also submit a similar photo of the original design.
4. Your entry must be in the mail by July 1, 1955 the contest closing date. Address: Redesign Contest, Gray Iron Founders' Society, Inc., National City-E. 6th Bldg., Cleveland 14, Ohio.
5. Contest is open to all persons engaged in the metal-working trades . . . entries may be made jointly by two or more individuals. Awards will be made at the 27th annual meeting of the Society in Milwaukee, Oct. 21, 1955.

These examples of previous award winners show how easy it is to be a winner yourself . . .



▲ 22 parts were eliminated when the fabricated design of this hydraulic circuit was redesigned in gray iron.



▲ Redesigning this table top in gray iron saved 15 hours in production time.

Original costs were reduced 83% by redesigning this screw nut as a cored gray iron casting. ▶

Make it better with Gray Iron

GRAY IRON FOUNDERS' SOCIETY

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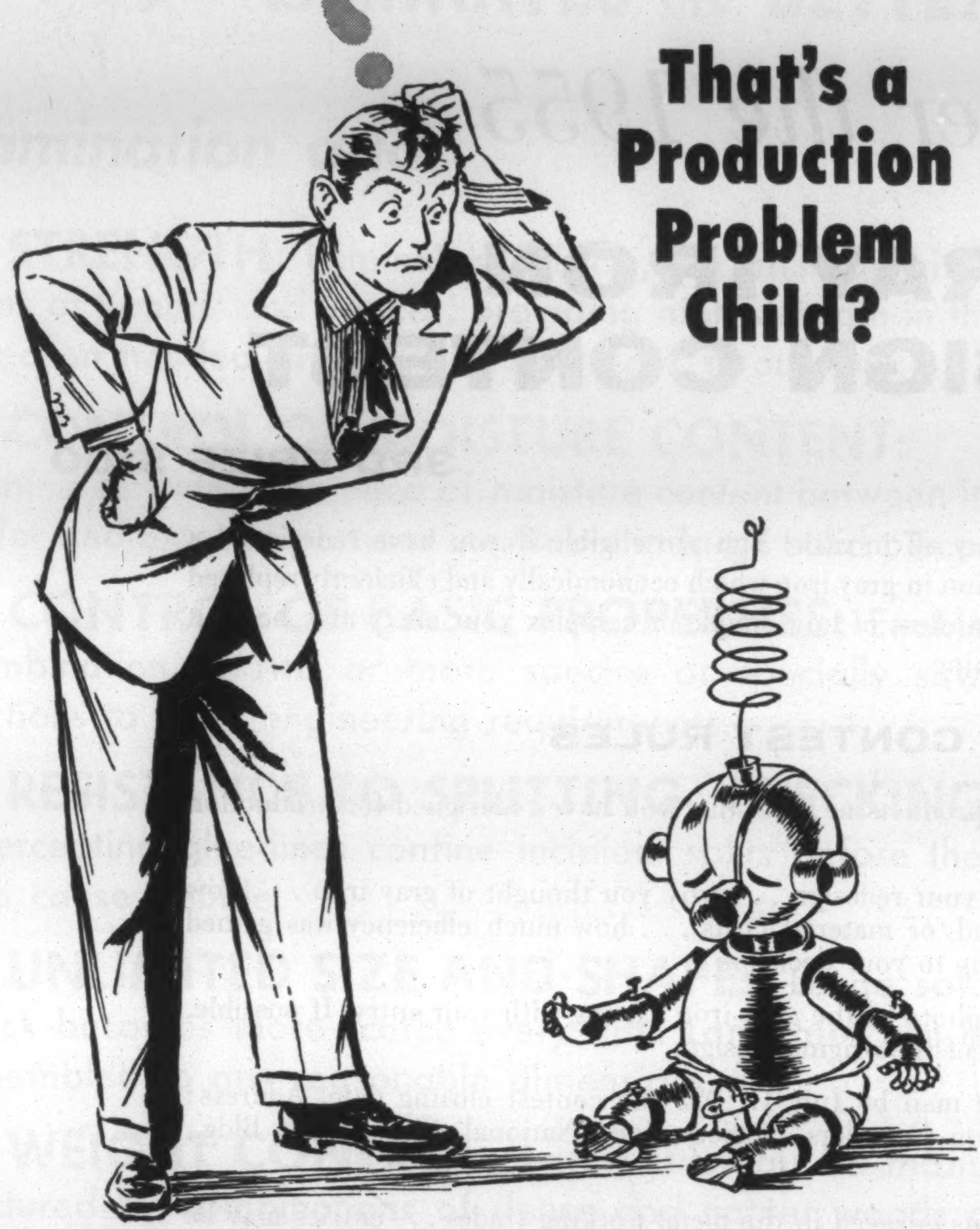
Do You Have a New "Baby"

That's a Production Problem Child?



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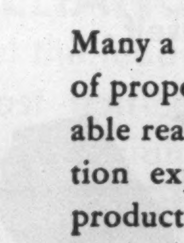

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Contents Noted

Reports . . .

gram. *Louise M. Koeker, U. S. Air Force, Air Research and Development Command, Wright Air Development Center, Materials Laboratory, Wright - Patterson Air Force Base, Dayton, Ohio, July 1954. PB 111537, 143 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Wash. 25, D.C. $3.75.* A review of the research and development work sponsored in the field of materials and processes over the past decade is presented. Abstracts of WADC Technical Reports for the period 1 July 1951 to 30 June 1953 are included. A summary of Technical Reports published in the areas of metallurgy, textiles, petroleum products, structural materials, rubbers, plastics, packaging, protective treatments, analysis and measurements are also included.

Catalogues of Available Reports

The CTR (Catalogues of Technical Reports) series of publications listed below are bibliographies of PB reports available in the subject category, and are published in cooperation with the Small Business Administration. These CTR's are revised editions of earlier series. Check or money order should be made payable to the Office of Technical Services, Department of Commerce.

Acrylics (Plexiglas and Lucite). *Mar. 1954. CTR-116. $.10.*

Adhesives. *May 1954. CTR-300. $.25.*

Aluminum Extrusion and Press Forging Processes. *Apr. 1954. CTR-289. $.10.*

Beryllium. *Apr. 1954. CTR-152. $.10.*

Cellophane. *Apr. 1954. CTR-61. $.10.*

Cellulose. *Apr. 1954. CTR-201. $.25.*

Cerium. *Mar. 1954. CTR-256. $.10.*

Cold Extrusion and Shaping of Steel. *May 1954. CTR-252. $.10.*

Contact Corrosion of Aluminum Alloys. *Feb. 1953. CTR-285. $.10.*

Cork and Corkboard. *May 1954. CTR-214. $.10.*

(Continued on page 210)

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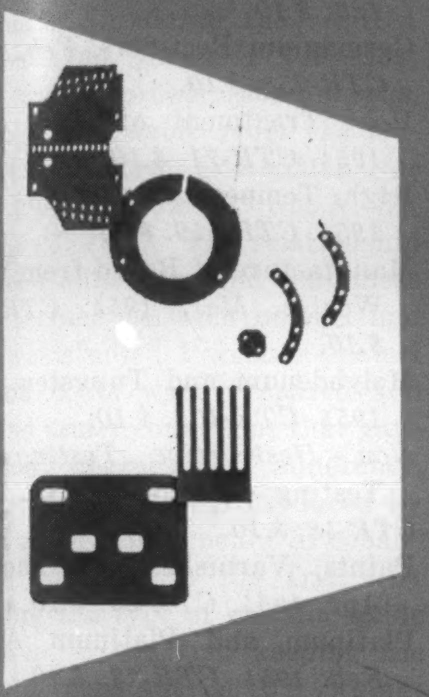

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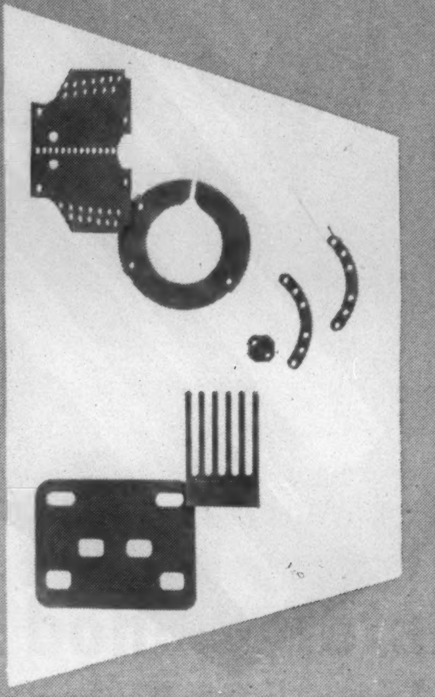
Fibrous sheet material for use as replacement for paper-base laminates where moisture absorption is not a critical factor. Arc resistance, tensile and impact strengths of DUROID 800 are greater than XP paper-base laminates. Listed by Underwriters' Laboratories.



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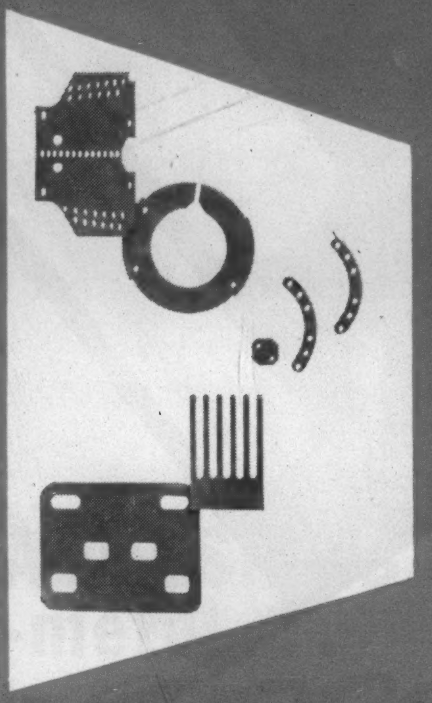

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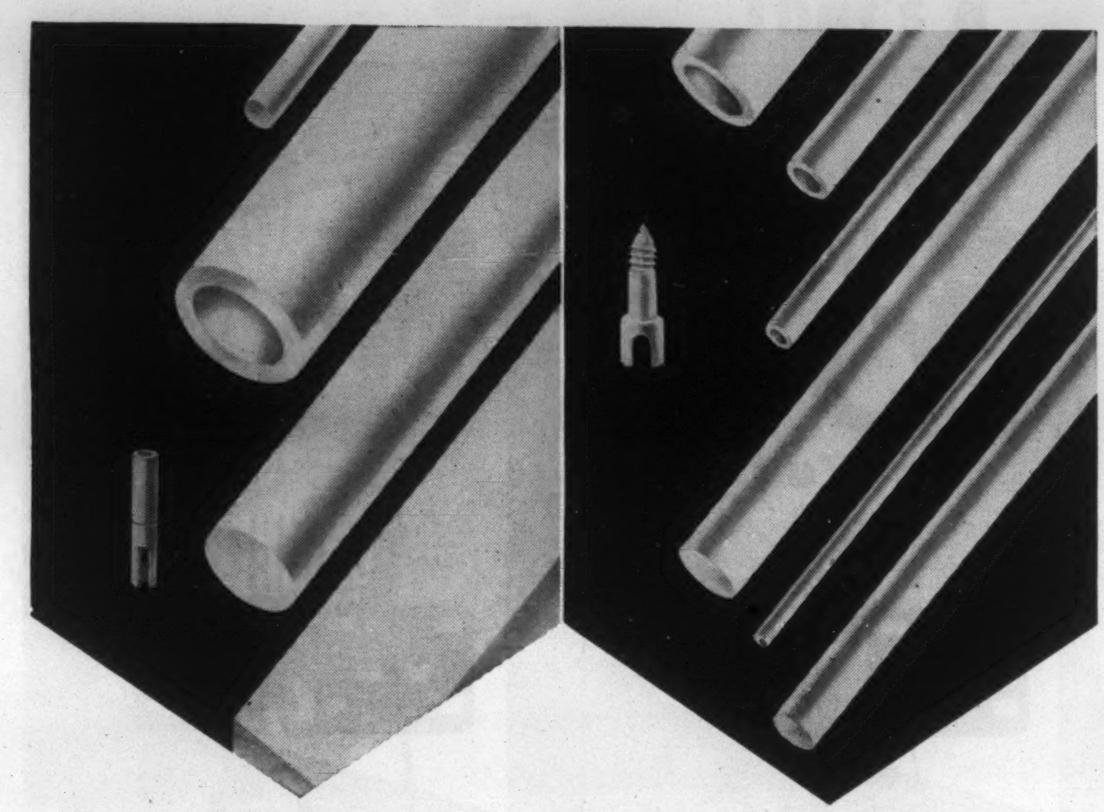

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Western Fibrous Glass Products Co., Los Angeles, Cal.

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Contents Noted

Reports . . .

Die Castings. *Apr. 1953. CTR-10. $.10.*

Electroplating. *Apr. 1954. CTR-159. $.10.*

Fiberglas and Glass Laminates. *May 1954. CTR-292. $.10.*

Fluorocarbons. *Mar. 1954. CTR-123. $.10.*

Germanium Rectifiers. *Feb. 1954. CTR-258. $.10.*

Heat Treatment of Steel. *Mar. 1954. CTR-71. $.10.*

High Temperature Alloys. *Mar. 1954. CTR-149. $.25*

Manufacture of Board from Wood Wastes. *Mar. 1954. CTR-188. $.10.*

Molybdenum and Tungsten. *Apr. 1954. CTR-101. $.10.*

Non - Destructive Testing and Testing equipment. *Apr. 1954. CTR-48. $.10.*

Paints, Varnishes and Laquers. *Apr. 1954. CTR-23. $.10.*

Platinum and Platinum Alloys. *Feb. 1954. CTR-73. $.10.*

Plywood and Veneers. *Apr. 1954. CTR-109. $.10.*

Impact Test For Cermets A Drop Test for the Evaluation of the Impact Strength of Cermets. *B. Pinkel, G. C. Deutsch, and N. H. Katz, Mar. 1955. NACA RM E54D13, 8 pp, diagrams, photographs. Available from the National Advisory Committee for Aeronautics, 1512 "H" St., N. W., Wash. 25, D. C.* The development of brittle high-temperature materials has focused attention on the impact resistance of these materials. This report describes a device for measuring very small values of impact resistance both at norm and elevated temperatures. The device is believed to eliminate extraneous energies, such as the "toss energy" from the impact strength. The method of testing consists of dropping a hammer from increasing heights so that it strikes near the free end of a cantilever beam specimen. The energy of the hammer when the specimen fractures is the impact strength. Representative values of the impact strengths of several high-temperature materials are given.

(More Reports on page 213)

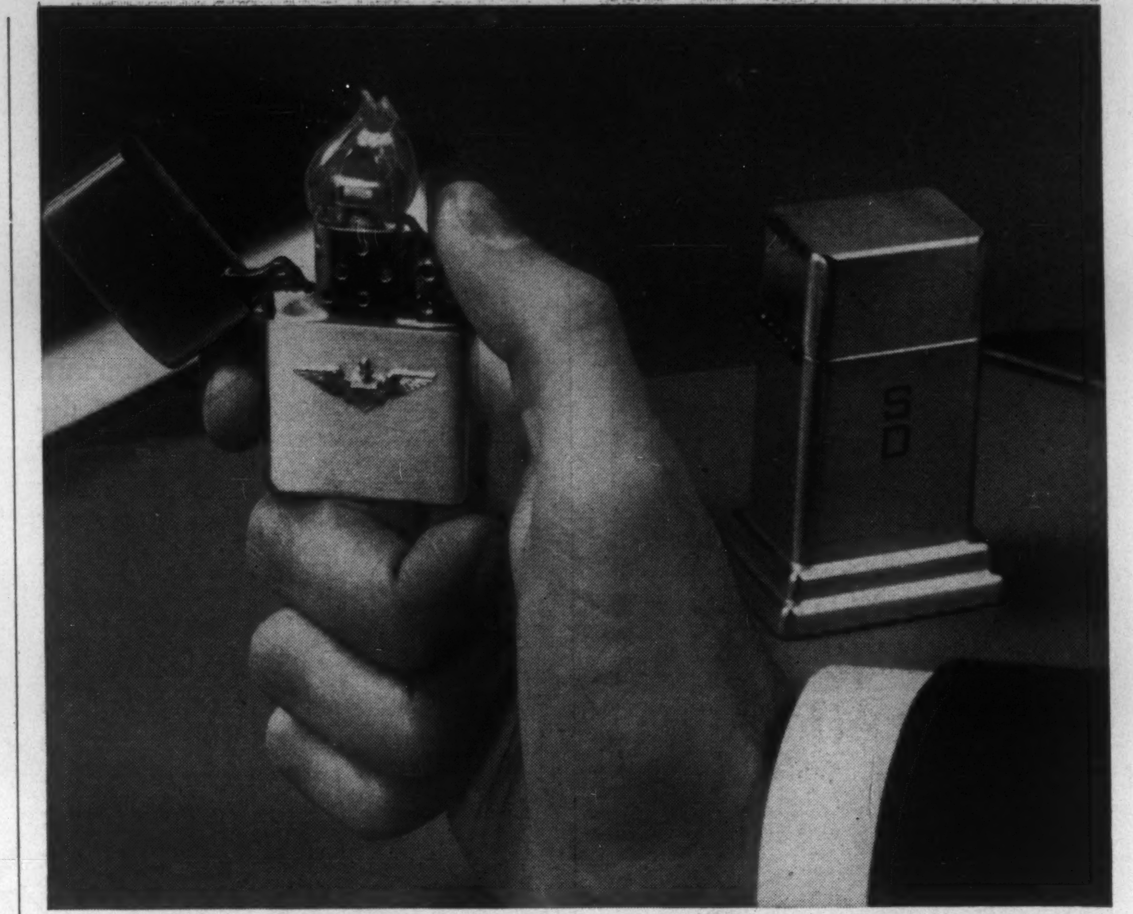
For more information, Circle No. 532

Contents Noted

Reports . . .

Porcelain Enamel and Steel Relation Between Roughness of Interface and Adherence of Porcelain Enamel to Steel. *J. C. Richmond, D. G. Moore, H. B. Kirkpatrick, and W. N. Harrison, National Bureau of Standards, 1954. NACA Report 1166, formerly TN 2934, ii, 9 pp, diagrams, photographs, 7 tables. Available from the National Advisory Committee for Aeronautics, 1512 "H" St., N. W., Wash. 25, D. C.* The relationship between adherence and roughness of interface between enamel and iron was studied. Porcelain-enamel ground coats were prepared and applied under conditions that gave various degrees of adherence. The variations were produced by (a) varying the amount of cobalt-oxide addition in the frit; (b) varying the type of metallic-oxide addition in the frit, keeping the amount constant at 0.8 weight percent; (c) varying the surface treatment of the metal before application of the enamel, by pickling, sandblasting, and polishing; and (d) varying the time of firing of the enamel containing 0.8 percent of cobalt oxide. A positive correlation was found between adherence and roughness of the interface.

Thermal Stress and Materials Behavior of Materials under Conditions of Thermal Stress. *S. S. Manson, 1954. NACA Report 1170, formerly TN 2933, 34 pp, diagrams, photographs, 6 tables. Available from the National Advisory committee for Aeronautics, 1512 "H" St., N. W., Wash. 25, D. C.* A review is presented of available information on the behavior of brittle and ductile materials under conditions of thermal stress and thermal shock. For brittle materials, simple formulas relating physical properties to thermal-shock resistance are derived and used to determine the relative significance of two indices currently in use for rating materials. The importance of simulating operating conditions in thermal-shock testing is deduced from the formula and is experi-



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Contents Noted

Reports . . .

mentally illustrated by showing that BeO could be both inferior or superior to Al_2O_3 in thermal shock depending on the testing conditions. For ductile materials, the thermal-shock resistance depends upon the complex interrelation among several metallurgical variables which seriously affect strength and ductility. These variables are briefly discussed and illustrated from literature sources. The importance of simulating operating conditions in tests for rating ductile materials is especially to be emphasized because of the importance of testing conditions in metallurgy. A number of practical methods that have been used to minimize the deleterious effects of thermal stress and thermal shock are outlined.

Molybdenum Alloys Arc - cast Molybdenum-Base Alloys. *Fourth Annual Report under Contract N8onr-78700, Task Order N8onr-78701, Project NR 039-002, for the period Aug. 1, 1952 through July 31, 1953. M. Semchyshen and R. Q. Barr, Climax Molybdenum Co., Detroit, Mich., 1953. PB 115974, 315 pp, photographs, graphs, tables. Available from Library of Congress, Publication Board Project, Wash. 25, D. C. Microfilm $9.25, Photocopy $40.25.* Twenty-two different alloys representative of five different binary systems have been produced on a pilot plant scale and have been fabricated by conventional commerical methods. Carbon - free molybdenum-vanadium and molybdenum-titanium alloys have been produced by deoxidation with rare earth metals in vacuum and have been hot worked successfully. The fourth year program has included the exploration of a series of graded castings of solid solution, molybdenum-rich, ternary alloys, each of which was composed of a different combination of two elements from the following group: aluminum, cobalt, niobium, titanium, vanadium and zirconium.

(More Reports on page 216)

FOSBOND FORUM

This column carries quotes from technical papers delivered on the subject of phosphate coating; answers questions about the use of Fosbond, Pennsalt's trouble-free phosphatizing process.

IRON PHOSPHATE COATING ADVANTAGES

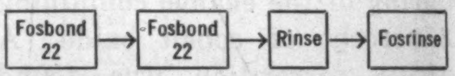
The Pennsalt Fosbond "20" series of iron phosphate coatings was first developed to overcome certain of the known disadvantages of zinc phosphates. They have now proved of considerable value in accomplishing two objectives:

1. TO INCREASE OVERALL ECONOMY. With the use of Pennsalt iron phosphates, coverage per pound is greater. Control is simplified. Bath life is lengthened. Both cleaning and phosphatizing are often combined into one simple operation. The need for an alkali cleaner prior to coating is often eliminated. This reduces consumption of phosphatizing compound, reduces waste, makes solution control much easier.

2. TO IMPROVE PAINT COVERAGE. Fosbond "20" series iron phosphate coatings are especially suited where it is necessary to use 1-coat paint systems. Coatings produced with Fosbond show remarkable uniformity in coating weight and in performance. Corrosion test performance is proved consistently superior.

QUESTION—
How are iron phosphate Fosbonds applied?

ANSWER—
Usually in this simple three or four stage cycle:



QUESTION—
How do zinc versus iron phosphates compare as to materials handling?

ANSWER—
Pennsalt supplies Fosbond series "20" as a dry powder, instead of in liquid form. Packed in non-returnable drums, it is easier to handle than the liquids used in zinc phosphatizing. With Fosbond "20" there is only *one* material to buy, store, handle, use.

QUESTION—
Does Pennsalt offer any advantages over other iron phosphates on the market?

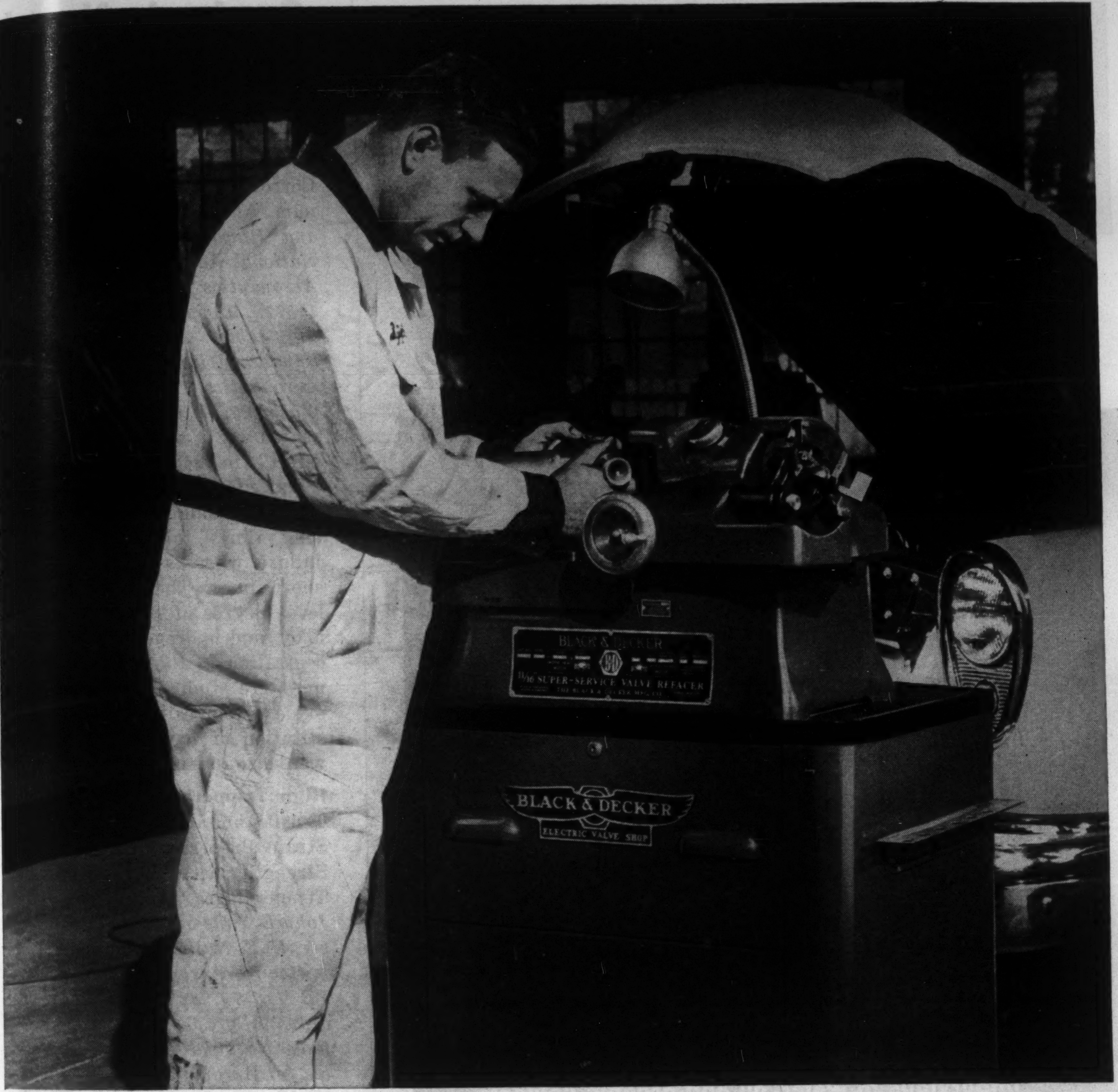
ANSWER—
Pennsalt believes that its Series "20" line delivers a superior cleaning action. Coatings are more uniform. The possibility of eliminating an alkali cleaner is more certain. Sold in *dry* form, Fosbond "20" guarantees savings in handling.

QUESTION—
Who is now using Fosbond iron phosphates to good advantage?

ANSWER—
Many leading manufacturers, among them Black & Decker, who report that their costs have been reduced and product quality increased with Fosbond. See opposite page for details.

For complete technical information about subjects briefed in the FOSBOND FORUM, or answers to your questions, write Customer Service Dept., Pennsylvania Salt Mfg. Co., 1066 Widener Bldg., Philadelphia 7, Pa.

Chemical Progress Week, May 16-21



Black & Decker Valve Refacers are used by better automotive shops throughout the country. The paint on these machines is anchored to the metal by the Pennsalt Fosbond Process.

Fosbond picked by Black & Decker for better adhesion of paint to metal

The Pennsalt Fosbond® Process for bonding paint to metal is used on a variety of Black & Decker products.

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Black & Decker reports their cost of cleaning metal before painting has been reduced. Better adhesion of paint to sheet metal surfaces has been obtained, and rust-resistance after painting is greater.

For better phosphatizing . . . to get a better start for your finish . . . check the Pennsalt Fosbond Process. There's an extra advantage in the Fosbond-Good Housekeeping seal which is available for merchandising use. A one-hour survey may improve your products, may make selling easier.

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Contents Noted

Reports . . .

Aluminum Stress Corrosion Influence of Exposed area on Stress-Corrosion Cracking of 24S Aluminum Alloy. *William H. Colner, and Howard T. Francis, U. S. National Advisory Committee for Aeronautics, Nov. 1954. PB 115778, 22 pp, photographs, drawing, table. Available from National Advisory Committee for Aeronautics, 1512 "H" St., N. W., Wash. 25, D. C.* Results are presented of a study of the "area effect" in 24S-aluminum alloy. This effect is the phenomenon whereby small exposed areas show long times to stress-corrosion failure, whereas large areas show short times. The effects of stress level, degree of sensitivity of the alloy, and hydrogen peroxide concentration in the corrosion medium were studied. Hydrogen peroxide decomposition and the substitution of oxygen for peroxide were also investigated.

High Temperature Stress-Strain Tensile and Compressive Stress-Strain Properties of Some High-Strength Sheet Alloys at Elevated Temperatures. *Philip J. Hughes, John E. Inge and Stanley B. Prosser, U. S. National Advisory Committee for Aeronautics, Nov. 1954. PB 115779, 32 pp, photographs, drawing, graphs, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St., N. W., Wash. 25, D. C.* Results of tensile and compressive stress-strain tests at temperatures up to 1200 F are presented for SAE 4340, Hy-Tuf, Stainless W, and Inconel X sheet materials which had ultimate tensile strengths at room temperature in the 170 to 220 ksi range. Representative tensile and compressive stress-strain curves are given for each material at the test temperatures. Secant and tangent moduli, obtained from the compressive data, are included.

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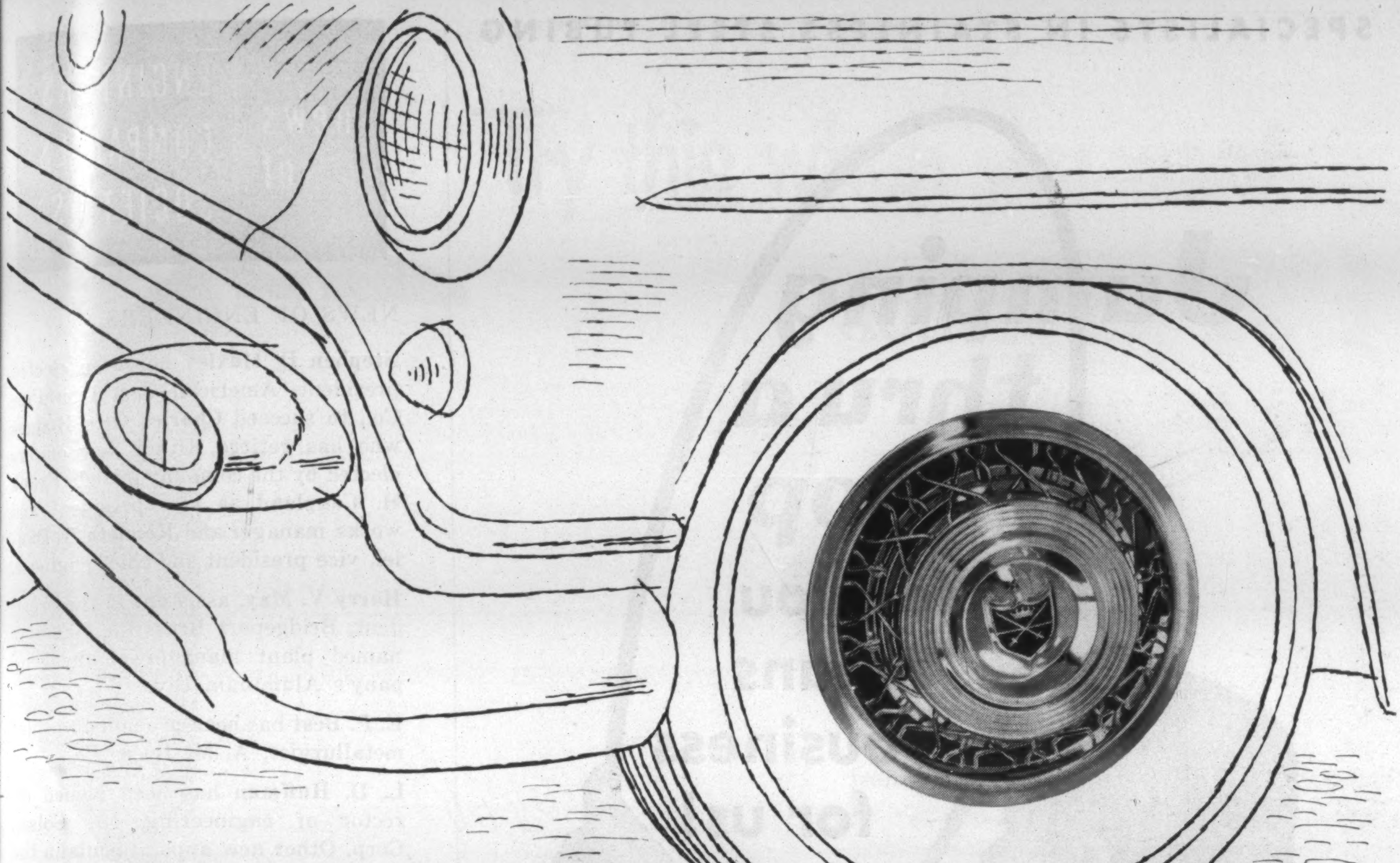

Wire wheel unit made by A. S. Campbell Co., Inc., East Boston, Mass. Hub section is formed on Ampco dies.

Auto-accessory manufacturer eliminates rejects, cuts costs with dies of **AMPCO*** *metal*

A. S. Campbell Co., Inc. switched to Ampco, forms hub caps without work scoring or roping

Forming the hub cap section of this wire wheel unit from 25-gauge stainless was a headache — and a costly one — for A. S. Campbell Co., Inc., East Boston, Mass. The material tended to score and rope in the die — and rejects piled up.

Then Campbell switched to Ampco Grade 24 dies. Result? Rejects dropped off to practically nothing.

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STAINLESS STEEL TUBING AND PIPE
Greenville, Pennsylvania

For more information, turn to Reader Service Card, Circle No. 357

news of ENGINEERS COMPANIES SOCIETIES

NEWS OF ENGINEERS

Stephen D. Moxley has been elected president, American Cast Iron Pipe Co., to succeed **Charles Otto Hodges** who has retired. Other new officers elected by the company include **Frank H. Coupland** as vice president and works manager and **Kenneth R. Daniel**, vice president and chief engineer.

Harry V. May, assistant to the president, Bridgeport Brass Co., has been named plant manager of the company's Aluminum Div.

E. P. Best has been promoted to chief metallurgist, A. M. Byers Co.

L. D. Huffman has been named director of engineering, the Colson Corp. Other new appointments in the company include **Edward Delon** as chief engineer of Colson's Elyria, Ohio, plant and **E. E. Nicholas** as chief engineer of the plant at Somerville, Mass.

Magnus A. Grunlan has been appointed plant manager, Dollin Corp.

Theodore W. Hager has been assigned the duties of vice chairman of the board, and **Russell B. Barnett** has been elected president, Peter A. Frasse and Co., Inc.

Dr. Frederic de Hoffmann has joined the Convair Div., General Dynamics Corp., as assistant vice president for nuclear planning.

Louis G. Helmick, Jr., has been elected vice president of manufacturing, Joy Manufacturing Co.

William D. Craddock has been named to head stainless steel fabrication at Kaiser Metal Products, Inc.

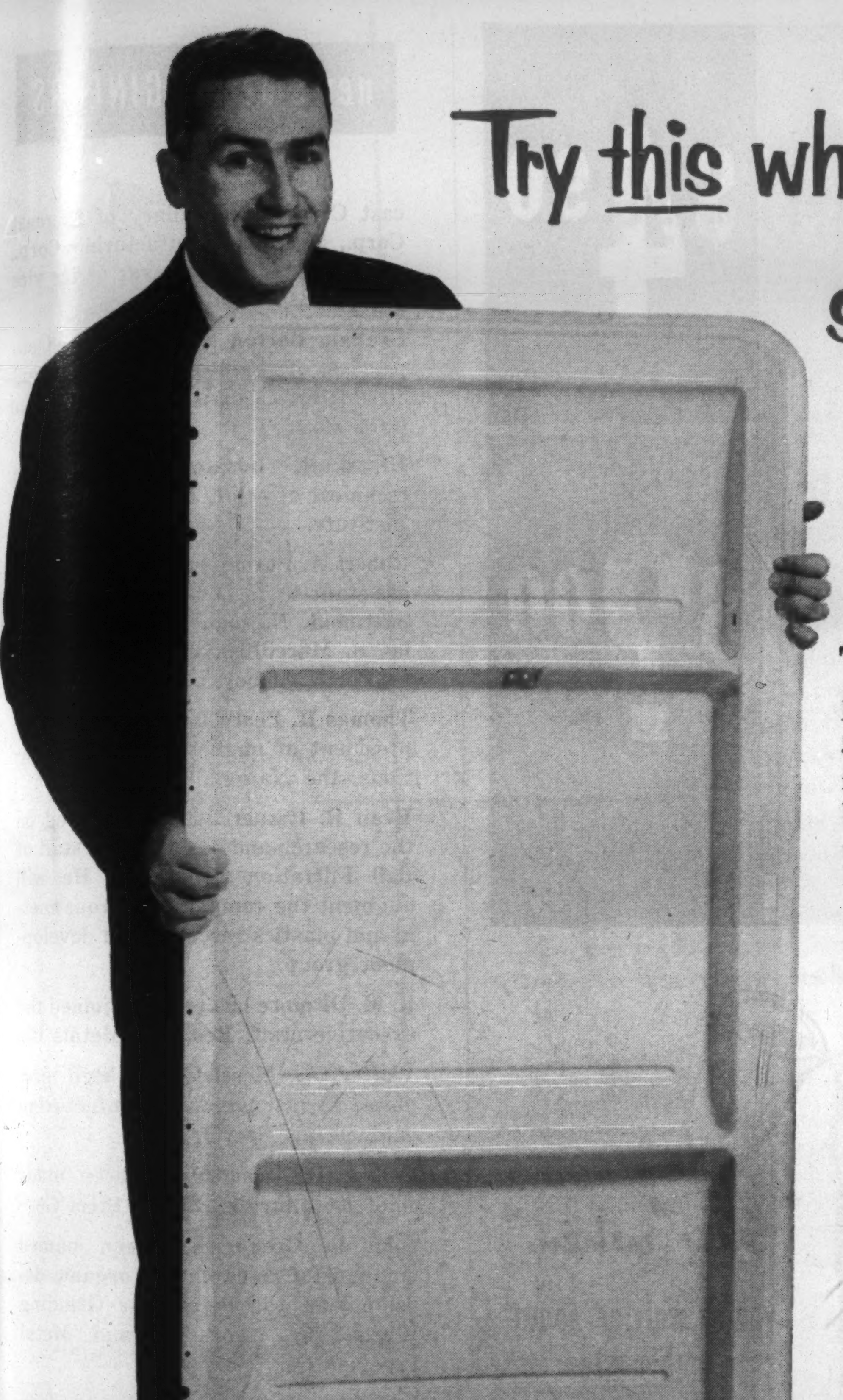
Dr. Benjamin S. Mesick has recently joined Arthur D. Little, Inc., as a senior staff member. His chief responsibility will be to expand the company's activities in the titanium fabrication field.

George P. MacNichol, Jr., has been appointed chairman of the board of the recently-formed L-O-F Glass Fibers Co.

A. M. Davis has been appointed chief of engineering and manufacturing services Powerplants Div., Marquardt Aircraft Co.

Dr. Fred Schulman has been made assistant director of research, Mer-

Try this when you want something BIG in plastics



This large-sized plastic section is made from Bakelite Brand High-Impact Styrene TGD-5001. It's tough. Its glossy surface is free from grain. It's intricately detailed—shaped by vacuum-forming—a fast, easy, low-cost production method.

TGD-5001 is specifically formulated for extrusion into sheets to be postformed later. Your plastics fabricator can extrude sheets of TGD-5001 with a gloss that is retained during subsequent vacuum-forming. In addition, TGD-5001 offers a wide range of brilliant colors for which styrene plastics are noted.

Refrigerator door panels, toys, display stands, and housings for air conditioners are typical of the products that can benefit from the combination of serviceability, eye-appeal and production advantages found in Bakelite High-Impact Styrene TGD-5001. Write Dept. HB-106 for further information.

Measuring 26 inches wide, 49 inches long, and 2½ inches at its deepest part, this refrigerator inner door panel typifies the large-sized, tough products that can be vacuum-formed from Bakelite High-Impact Styrene TGD-5001. It was produced by **General American Transportation Co.,** Chicago, Ill.

B

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Figure what it would cost—at your overhead—to produce, handle and stock the six brass, copper and steel parts that formerly went into this assembly. Then add fabrication costs, with an allowance for leaker-rejects that showed up all too frequently.

We can't promise you savings like this, of course. But the expendable pattern process gives product designers a free rein; your men *imagine* what they'd like to have and we cast it for them. Many machining and assembly operations can be eliminated and, often, parts are made in alloys that can't be machined—a fraction of an ounce up to 10 pounds.

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INVESTMENT CASTINGS

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news of | ENGINEERS

cast Corp. A subsidiary of Mercast Corp., Mercast Manufacturing Corp., appointed **A. F. Anzlovar** as its vice president.

Graham Barton has been named supervisor of engineering, Walsh Metal Products, a division of Michigan Oven Co.

Dr. M. H. Thornton has been made technical director, Midwest Research Institute.

Robert A. Putney has been appointed assistant to the manager, Metal Department, National Lead Co. **Nicholas S. Muccilli** succeeds Mr. Putney as Perth Amboy plant manager.

Thomas H. Peace has been made vice president of engineering and operations, the National-Standard Co.

Evan R. Rotner has been placed on the research and development staff of Pall Filtration Companies. He will augment the companies' porous metal and plastics research and development group.

R. M. Ditmore has recently joined the executive staff, Red Seal Metals Co.

Walter A. Messick has been promoted to manager of manufacturing engineering, Servel, Inc.

Col. J. H. Dasdorf has been made chief metallurgist, Shultz Steel Co.

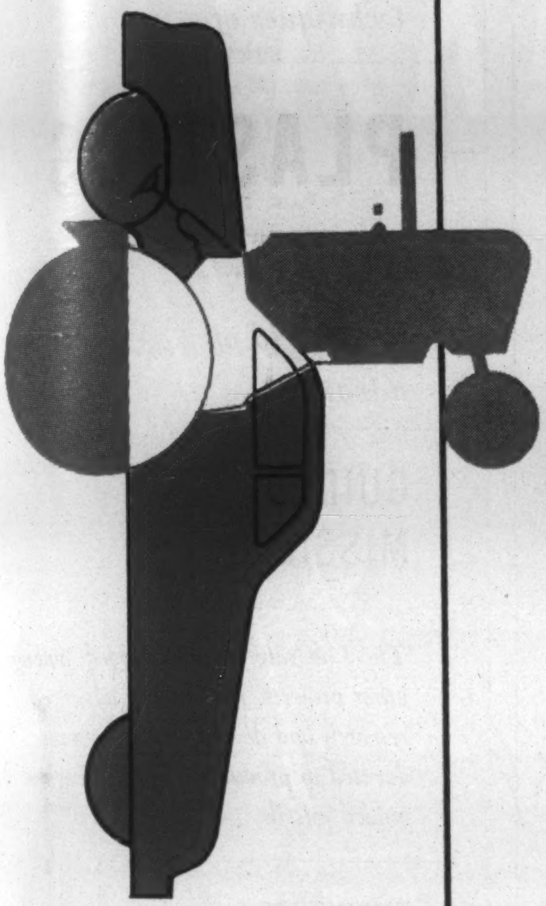
John R. Gregor has been named manager of research and organic development, the Peninsular Grinding Wheel Div., Abrasive and Metal Products Co.

Leslie B. Bellamy has been made general manager of operations, Sterling Grinding Wheel Co. Other new appointments in the company include **Gilman F. Farley** as works manager and **L. V. Dippell** as manager of research and development.

J. Gordon Seiter has been appointed manager of the newly-established High Vacuum Div., F. J. Stokes Machine Co., Inc., and **G. Jewett Crites** has been made manager of the company's Vacuum Processing Div.

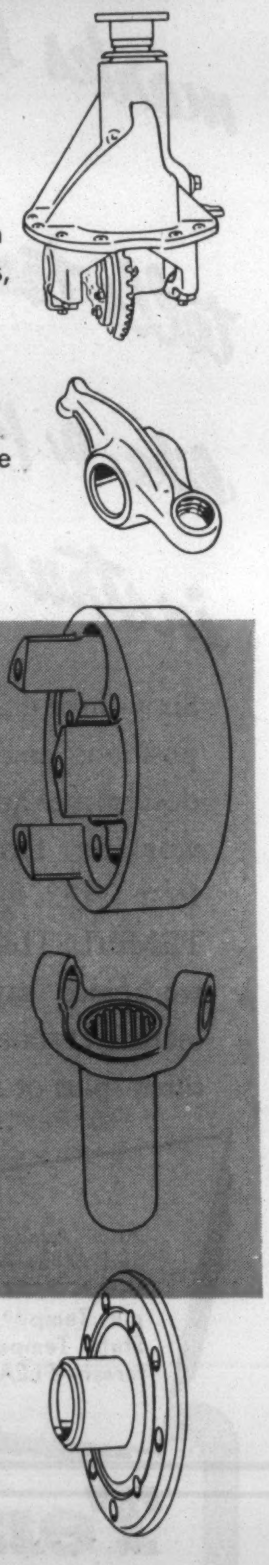
Don G. Mitchell, chairman of the board, Sylvania Electric Products Inc., has been given the additional capacity of president of the company to fill the vacancy caused by the recent death of **H. Ward Zimmer.**

Dr. Cecil B. Ellis has been named director of nuclear engineering as head of a newly-established Nuclear En-



PEARLITIC CASTING permits wider

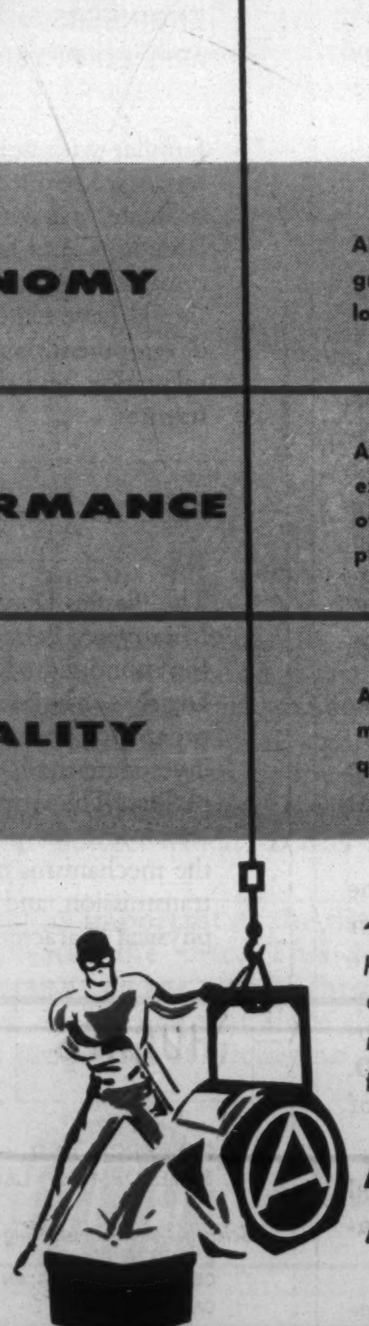
FREEDOM OF DESIGN



Albion's *pearlitic* malleable irons can be cast to your specifications with physical properties to suit your specific range of applications. For only *pearlitic* malleable irons combine the advantages of both castings and forgings and can be produced to extremely close dimensions, in large quantities, with greater freedom of design and *at lower cost.* Albion's complete manufacturing facilities provide the rigid metallurgical control through all phases of production to guarantee more uniform quality in the finished casting.

Contact your Albion Malleable Iron Company representative now, and see for yourself how many ways Albion's pearlitic irons can save you time, tools and dollars.

ECONOMY	**Albion's *pearlitic* malleable irons offer complete freedom of design for greater savings in machining time, the elimination of excess metal and lower finished part cost.**
PERFORMANCE	**Albion's *pearlitic* malleable irons afford unusually fine wear resistance with excellent bearing properties. Maximum rigidity and prolonged fatigue life offers outstanding endurance. Yield strength comparable to steel forgings plus good damping capacity.**
QUALITY	**Albion's *pearlitic* malleable irons have a fine, uniform grain structure that machines easily and accurately with exceptional mirror-smooth finishing qualities. Extremely adaptable to localized hardening for specific needs.**



Laboratory Service... *whether you are designing new products or reviewing present production, Albion's Research and Development Laboratory facilities and competent engineering staff are ready to help you design better products that can be made at lower cost.*

ALBION MALLEABLE IRON CO.

Albion, Michigan

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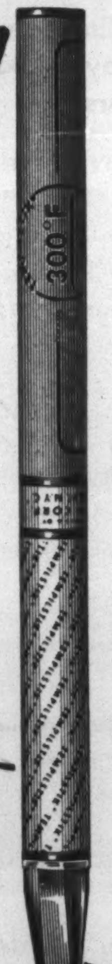

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news of | ENGINEERS

gineering Department, Universal Winding Co.

Dr. Hyman Chessin has been appointed assistant director of research and development, Van der Horst Corp.

Joseph G. Schaefer, vice president operations, Wyckoff Steel Co., has retired. At the company's Ambridge, Pa., works, new appointments include **Walter F. Wacht** as works manager, **Edsel E. Bishop** as metallurgist and manager product development, **William C. Undercoffler** as chief engineer, and **Gregor W. Betz** as assistant to chief engineer. At the company's Chicago works, **Kenneth K. Boyd** was appointed works manager.

Harry G. Stoddard has been named chairman of the board of directors, Wyman-Gordon Co., and **Robert W. Stoddard** has been made president of the company.

Elbert R. Faust has been elected vice president in charge of manufacturing, Waterman Pen Co.

Rex Rainey has been appointed chief engineer, Oil Seal Div., Yale Rubber Manufacturing Co.

Milan P. Getting, Jr., has been appointed assistant to the general manager at Allis-Chalmers Manufacturing Co.'s Pittsburgh works. The following promotions were made at the company's Boston works: **H. L. Peek** to engineer-in-charge of the development group, **W. L. Vance** to engineer-in-charge of circuit breaker design, and **J. F. Claffie** to section engineer for high voltage outdoor breakers.

Dr. Randall Royce has been appointed manager of American Can Co.'s Atlantic Div. laboratory at Newark.

J. L. Meem, Jr., has been given the key appointment of chief reactor scientist in American Locomotive Co.'s Atomic Energy Products Department. The company has also appointed **Rear Admiral Wilson D. Leggett, Jr.,** as vice president of engineering.

John E. Srawley has joined Arwood Precision Casting Corp. in the capacity of standards engineer.

George W. Kross, Jr., has been promoted to superintendent of the Tu-

To those qualified in the techniques of

PLASTICS

as applied to the field of advanced

GUIDED MISSILES

The Laboratories are engaged, among other projects, in a highly advanced research and development program devoted to production of the Hughes guided missile.

ENGINEERS *or* APPLIED PHYSICISTS

familiar with non-metallic materials are required to plan, coordinate, and conduct special laboratory and field test programs on missile components. These men should have experience in materials development, laboratory instrumentation, and the design of test fixtures.

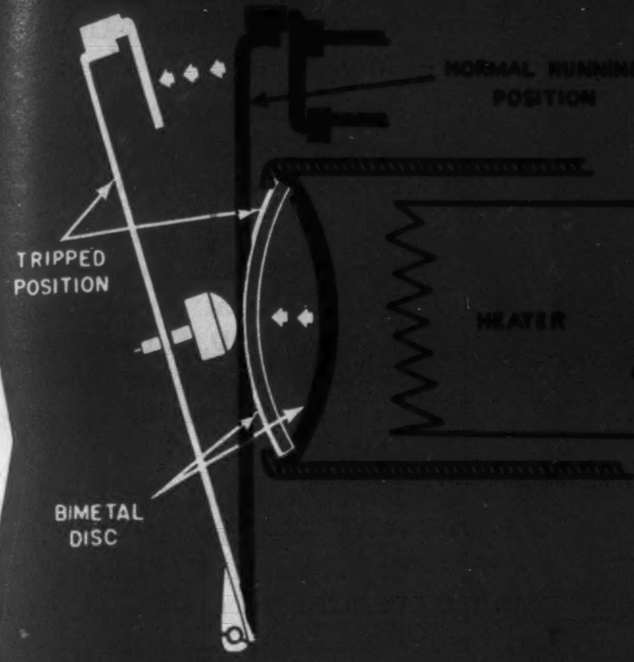
RESEARCH CHEMIST

The Plastics Department of the Microwave Laboratory has need for an individual with a Ph.D. Degree, or equivalent experience in organic or physical chemistry, to investigate the basic properties of plastics. The work involves research into the properties of flow, the mechanisms of cure, vapor transmission, and the electrical and physical characteristics of plastics.

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES
Scientific and Engineering Staff
CULVER CITY, LOS ANGELES COUNTY, CALIFORNIA

CLICK! ...and your motor is saved!

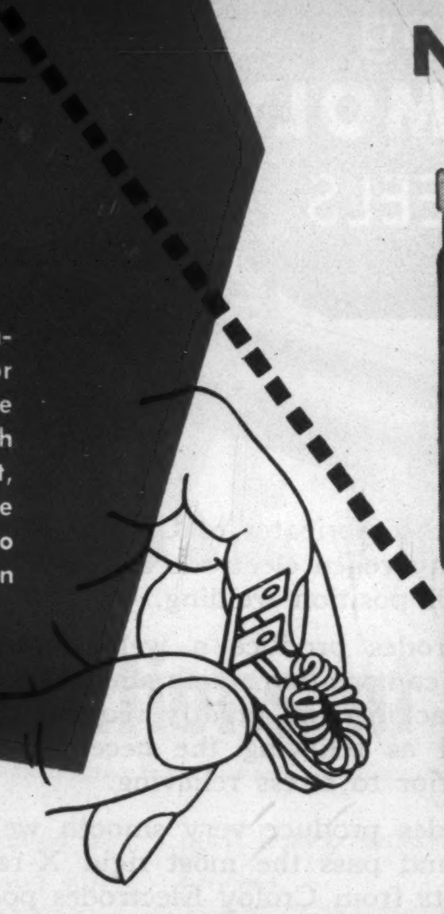


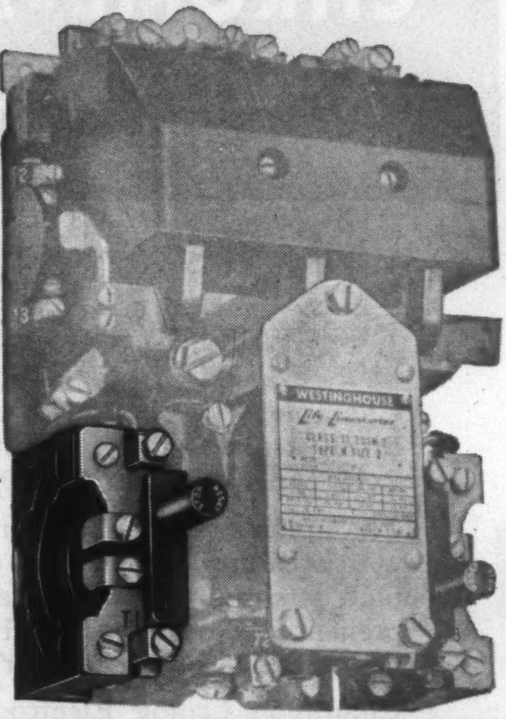
WESTINGHOUSE

offers a surer method of preventing motor burnouts ...the heater is made of

NICHROME*

HERE'S HOW IT WORKS. At a certain temperature, just below that of a dangerous motor overload, a bimetallic disc snaps from concave to convex, instantly breaking the contacts which carry power to the motor. The heater element, made of Nichrome, is wired in series with the motor, acting as a monitor to apply heat to the disc, at precisely the right moment and in the right amount.





The Westinghouse "Life-Linestarter"

Overload controls for electric motors are of course nothing new—but Westinghouse in its Life-Linestarter offers a basically improved, more reliable type of protection against this costly hazard. Whereas other types, depending on solder, gradually lose their critical calibration as the solder oxidizes . . . Westinghouse protects your motors by a bi-metallic disc type overload relay—a precision device which retains its calibration indefinitely.

Every bit as important as the disc is the heater which actuates the disc. This heater element Westinghouse makes of Nichrome, knowing from long experience that since the thermal and electrical properties of Nichrome do not change, the heater retains indefinitely the sensitivity of performance which is all-important.

Like Westinghouse, many leaders of American industry select Nichrome, since they know that the peerless qualities of Driver-Harris alloys are the result of the most precise metallurgical checks and controls. It is these exclusive quality controls that have long made Nichrome V and Nichrome the standard by which all other electrical resistance alloys are measured.

And if the alloy you need does not yet exist, our engineers will be happy to start tomorrow to develop a new one, custom-made for you. Just let us know exactly what you wish to accomplish.

*T. M. Reg. U. S. Pat. Off.

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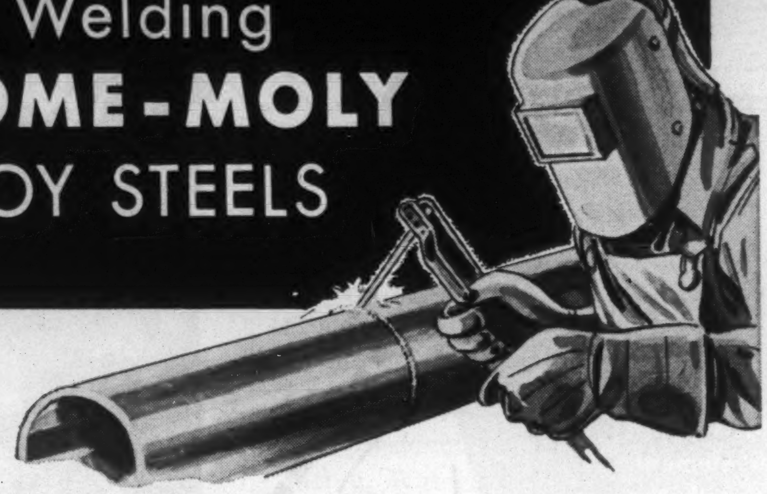

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PIONEERS AGAIN—

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NEW ELECTRODES
for Welding
CHROME-MOLY
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Champion now brings to the fabricator of Chrome-Moly Steels a new type of low hydrogen electrode of the AWS xx15 type, excellent for all position welding.

Champion's Croloy Electrodes produce a weld deposit with a carefully controlled composition which almost completely eliminates weld cracking and greatly reduces the preheat necessary as well as relieving the necessity of maintenance of preheat prior to stress relieving.

Champion Croloy Electrodes produce very smooth weld deposits in all positions and pass the most rigid X-ray requirements. Weld deposits from Croloy Electrodes possess very high ductility, 20-26% in the as-welded condition, and 24-30% stress relieved at 1350°F, as well as show stress-to-rupture properties equal to or exceeding that of the plate material. Champion Croloy Electrodes 3/32" through 3/16" diameters are available in grades for welding .5% Cr, .5% Mo through 5% Cr, .5% Mo material.

Complete technical data on Champion Croloy Electrodes will be furnished upon your letterhead request. Write Now! Dept. M

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For more information, turn to Readers Service Card, Circle No. 492

news of ENGINEERS

bular Products Div., the Babcock & Wilcox Co.

Robert B. Murray, Jr., has been made special assistant to the president, the Baldwin-Lima-Hamilton Corp.

Roy L. Blanchard has been elected president and general manager, Beaver Precision Products, Inc.

Dr. B. David Halpern has been named research director of Borden Co.'s Chemical Div. Research Laboratory, and **D. F. Gould** has become assistant to the vice president and technical director of the company's Chemical Div.

Joseph A. Geuss has been appointed chief engineer of the Hamilton, Ohio, plant of Clearing Machine Corp., division of U. S. Industries, Inc.

Edward C. Leibig has been made manager of the newly-formed Market Development Department, Technical Products Div., Corning Glass Works.

Robert C. Sutter has been promoted to the newly-created position of assistant director of engineering, Central Engineering Department, Diamond Alkali Co. **Edward J. Loeffler, Jr.,** succeeds Mr. Sutter as chief group engineer for the department.

H. R. Mick, Jr., has been appointed general superintendent of manufacturing, A. B. Dick Co.

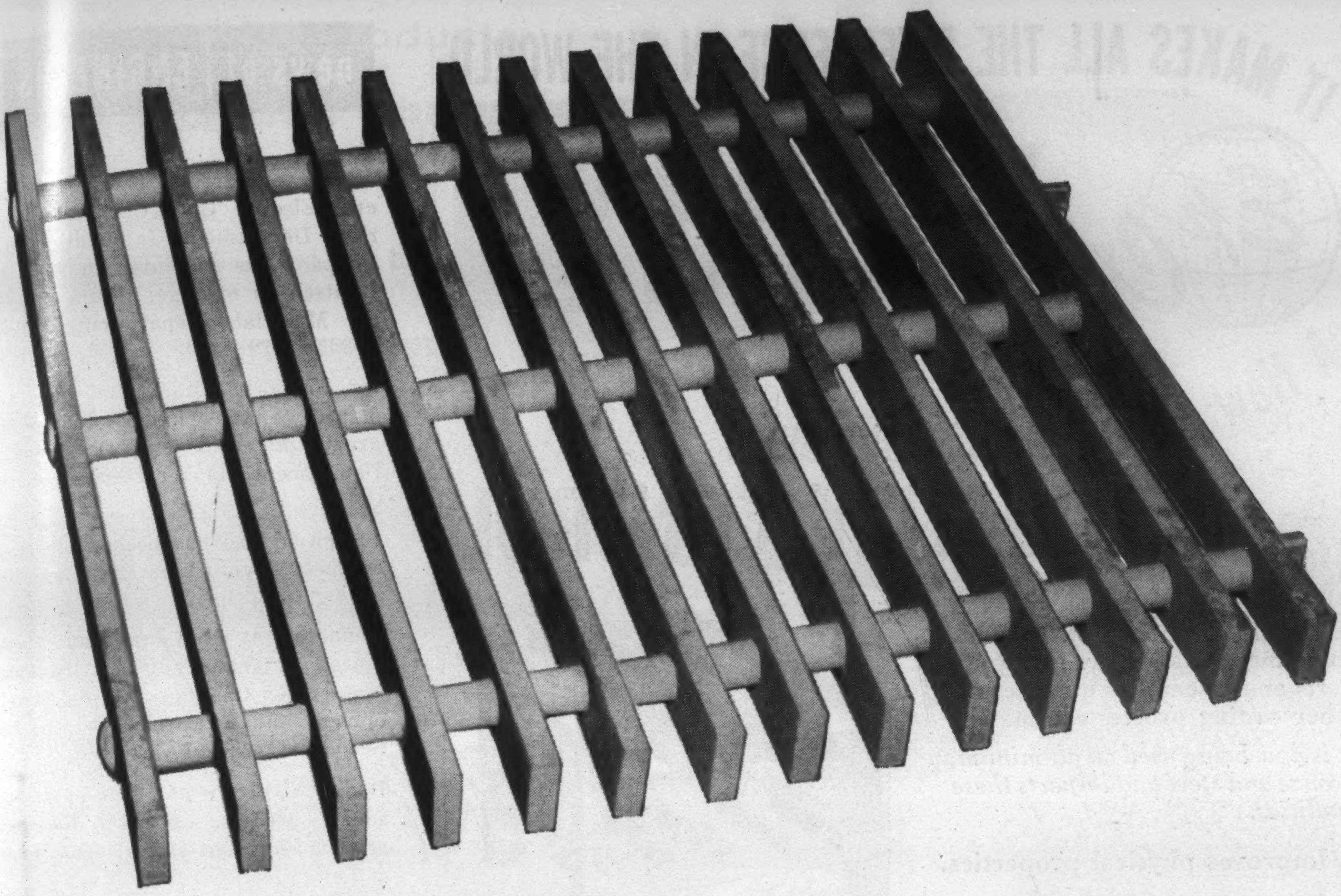
Dr. J. L. McCurdy has been advanced to assistant manager, Plastics Production Department, the Dow Chemical Co. **Daniel W. Ryan** has been made manager of the Torrance plant to succeed Dr. McCurdy.

Edgar R. O'Brien has been elected to the newly-created position of vice president and general manager, Edgcomb Steel of New England, Inc.

Stanley W. Moulton has joined the engineering staff of Hitchiner Manufacturing Co.

William M. Williams has been appointed manager of the Chrysler Detroit Tank Plant, operated by Chrysler Corp. for the Ordnance Corps, Department of Army. Also newly appointed by the company was **Hayward F. York** as operating manager, Chrysler Jet Engine Plant.

Dr. A. Eugene Schubert has been



STILL LIKE NEW

...After 100 Operations at 2300 deg. F

This tray made of HASTELLOY alloy X has been heated to 2300 deg. F on more than 100 different occasions and still shows no signs of oxidation or distortion. In each cycle the tray is heated to 1300 deg. F for an hour, and then to 2300 deg. F for an additional half hour. Trays made from other materials, and used under the same conditions, failed from oxidation and warpage after a few firing cycles.

The tray is 18 in. square and is fabricated from HASTELLOY alloy X sheared plate. It is used to support heavy molds during a tungsten carbide bonding process.

HASTELLOY alloy X has given similar good service in other furnace applications such as muffles, flame targets, rollers, and heating tubes. It is equally suitable for use in jet engine tailpipes, afterburner components, and other aircraft parts exposed to heat and oxidation.

For complete information on properties and forms, ask for the booklet, "HASTELLOY Alloy X."

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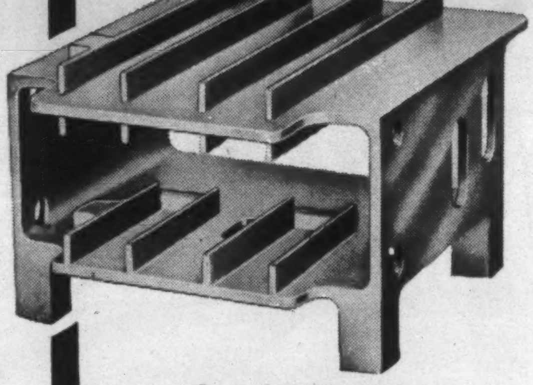
An EPCO development, Vacuum Investment Casting can give your parts and assemblies qualities no other casting process can match.

It is now being used on aluminum, bronze and steel and imparts these qualities.

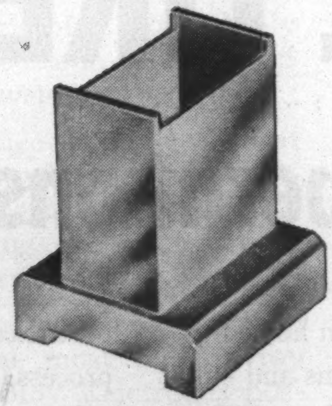
1. Improves physical properties.
2. Improves surface finish.
3. Produces pressure tightness comparable to bar stock and forgings in aluminum and copper-base alloys.
4. Permits greater use of poor castable materials such as magnetic iron, pure copper, invar and radar plumbing materials such as aluminum 2S and 61S which are used for their better weldability.
5. Permits design of sharper corners, thinner sections than previously possible even with centrifugal casting.

In EPCO's new Vacuum Casting process may lie opportunities for further improving parts now cast, and equally important for casting parts and assemblies never before considered possible.

Investigate the savings in production costs and improvement in quality and design by getting an EPCO quotation before machining or assembling your intricate parts.



Part for Aircraft
Aluminum 356-T6



Radar Plumbing
Aluminum 61-S

Solenoid Housing
Magnetic Iron

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news of ENGINEERS

named manager-engineering of General Electric Co.'s Chemical Materials Department. In addition, the company has appointed **Dr. John A. Loritsch** as manager of the Chemical Materials Department's Alkyd Products Plant.

Dr. Burton S. Marks has been assigned to the plastics and resins group, Research and Development Department, Hooker Electrochemical Co.

Joseph I. Bosi has been made chief engineer, Hydro-Line Manufacturing Co.

Kenneth A. DeLonge has been placed in charge of the Iron and Nonferrous Castings Section, Development and Research Div., the International Nickel Co., Inc.

Dwight C. Brown has been appointed senior process engineer, Research and Development Department, Jones & Laughlin Steel Corp.

John W. Miller has been named manager of product planning, Kaiser Steel Corp.

W. F. Munnikhuysen has been elected chairman of the board and **Fred C. Foy**, president and chief executive officer, Koppers Co., Inc.

Eibe W. Deck has been elected vice president in charge of production and **Earl F. Riopelle**, vice president in charge of engineering and research, Lunkenheimer Co.

Don S. Conner, in addition to his position as executive vice president, Micromatic Hone Corp., has been named general manager of the company. **R. G. Ellis** is the firm's new chief engineer.

Edward C. Bloomberg has been elected president, Monarch Aluminum Mfg. Co.

Roy H. Olson has been appointed director of engineering, Communications & Electronics Div., Motorola, Inc.

Carl A. Eversman has been made manager of Mullins Manufacturing Corp.'s Salem, Ohio, plants.

Gordon Kiddoo has been elected vice president-development, National Research Corp.

Gerard A. Albert has been named manager of manufacturing and **Henry C. Guhl**, manager of engineering, National Vulcanized Fibre Co.

(More News on page 228)

Visualize your products
using vitreous enameled aluminum castings

Picture the added sales appeal... with radiant color... surface protection ... design potential... plus the basic advantages of aluminum castings.

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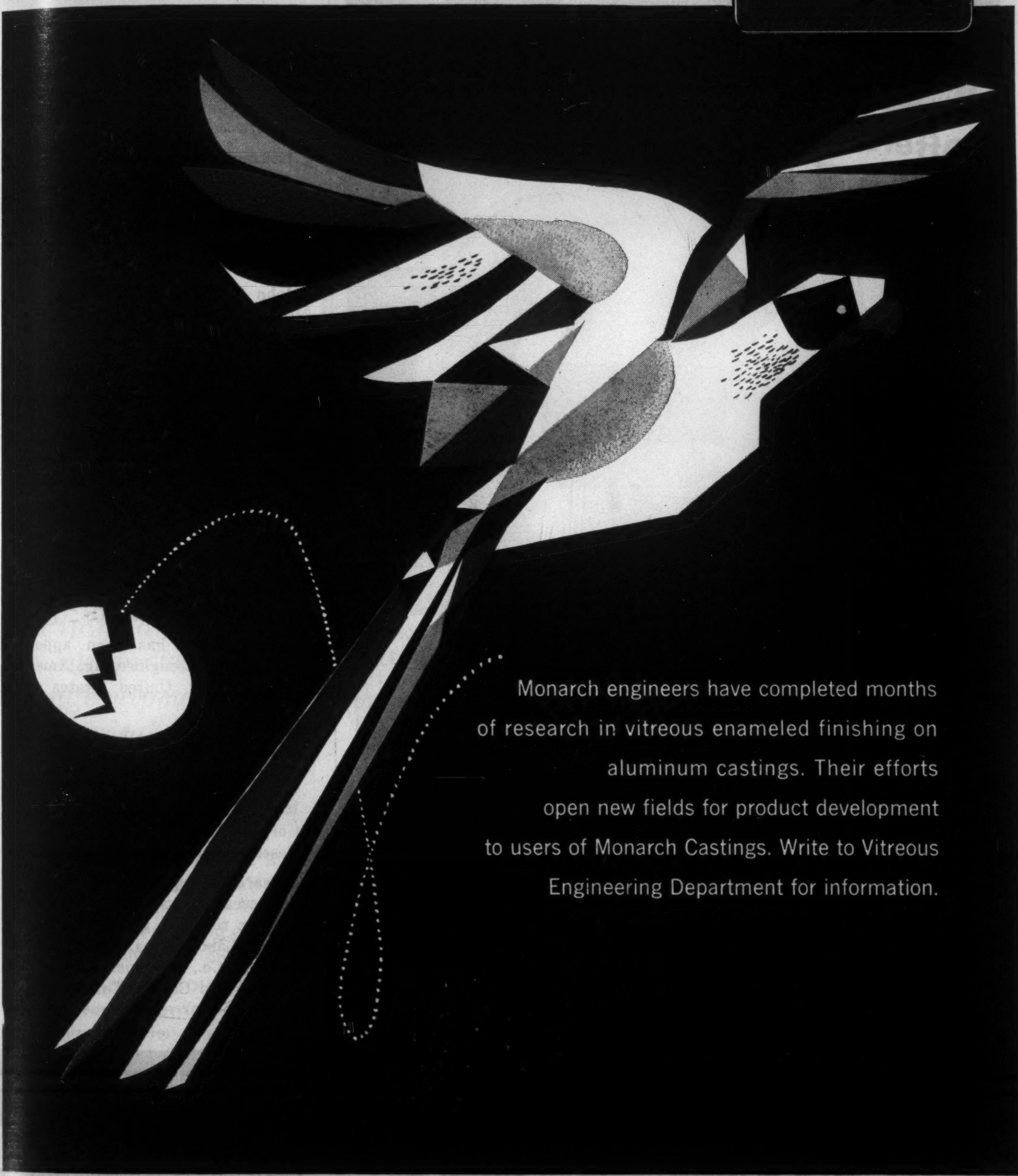
ALUMINUM



Monarch engineers have completed months of research in vitreous enameled finishing on aluminum castings. Their efforts open new fields for product development to users of Monarch Castings. Write to Vitreous Engineering Department for information.

MONARCH ALUMINUM MFG. COMPANY—9215 DETROIT AVENUE—CLEVELAND 2, OHIO

MANUFACTURERS OF: *Aluminum Permanent Mold Castings • Zinc Die Castings • Aluminum Die Castings Exclusive Velvaglaze Finishing • Vitreous Enamel Finishing.*

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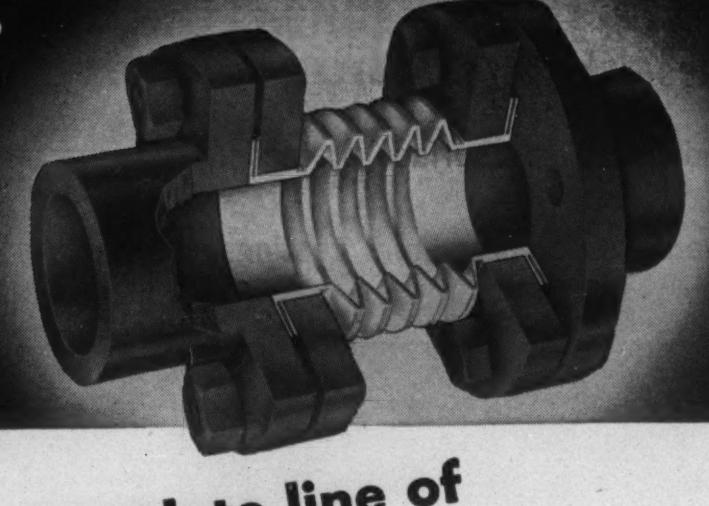
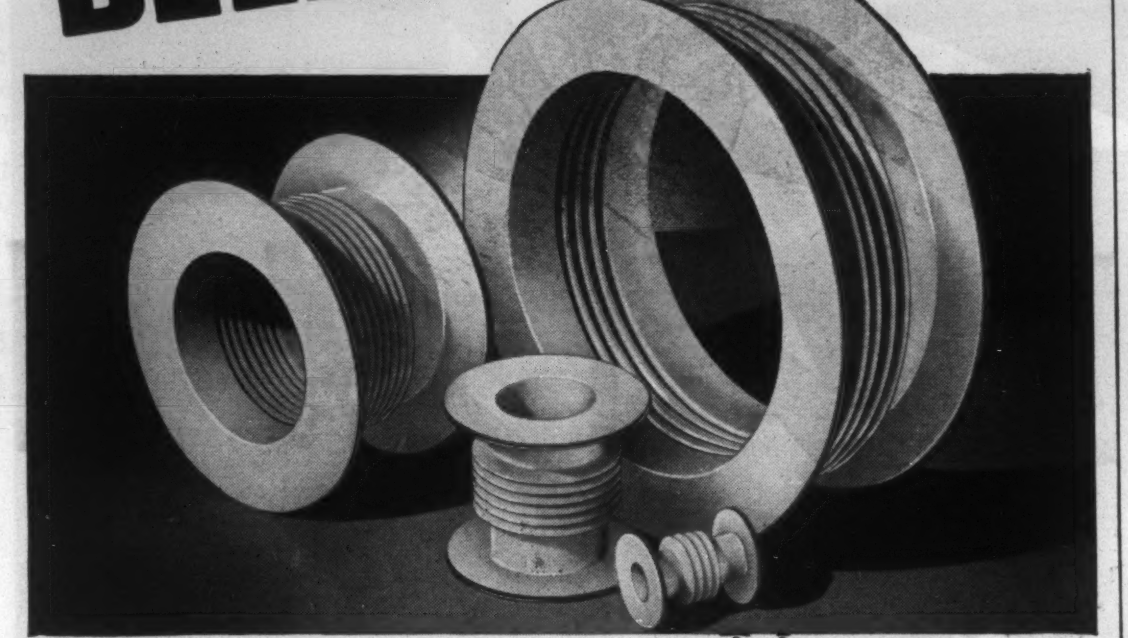
to handle
those
difficult
piping
problems



JOHN CRANE
Offers a complete line of
BELLOWS MADE OF TEFLON*



❶ **Chemically inert** —will handle all corrosive liquids, petroleum products, gases and solvents.

❷ **Life-long flexibility** —will not damage or fatigue under severe vibration or repeated expansion and contraction.

❸ **Outstanding electro-chemical properties** —eliminate electrolysis in the handling of chemicals, acids, etc.

❹ **Wide temperature range** —flex perfectly and otherwise physically unaffected over a wide temperature range.

"John Crane" Bellows provide a positive answer in the transmission of any type hydraulic or lubricating fluid, including the newly developed synthetics. Impervious to practically all known corrosive liquids and gases, they are unaffected by temperatures from −300° to +500°F.

Made from a special densely molded stock and so machined that there is no inherent stress at their free length—*they expand and contract in either direction with equal freedom of motion.* End flanges of French-type gasket construction facilitate easy assembly and assure a leak-proof seal. Stock sizes are available in a full range of standard pipe dimensions from 1 to 8 in.

Bellows are also available in a wide range of designs suitable for metering pumps, pressure accumulators, batching scale connectors, etc.

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CHEMLON

Further information on Teflon parts and products is available in "John Crane's" 12-page illustrated catalog, "The Best in Teflon." Send for your copy now. Crane Packing Company, 1827 Belle Plaine Ave., Chicago 13.
In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY

**DuPont Trademark for tetrafluoroethylene resin.*

For more information, turn to Reader Service Card, Circle No. 415

news of | ENGINEERS

Martin H. Olstad has been elected vice president in charge of engineering, Niagara Blower Co.

Ralph Wechsler has been elected president, Nopco Chemical Co., to succeed **Thomas A. Printon** who will continue to serve as chairman of the board.

Thomas I. S. Boak has been appointed superintendent of manufacturing, Fabricating Div., the Plume & Atwood Mfg. Co.

Lawrence J. Koller has been named director of research, Pontiac Varnish Co., to inaugurate a substantial expansion of the company's research services in industrial protective coatings and finishes.

John S. Davey has been promoted to vice president, Russell, Burdsall & Ward Bolt & Nut Co.

Louis Srybnik has been made director of a Special Projects Div., S & S Machinery Co.

Bruce A. Willsey, manager of the Manufacturing Div. of Solar Aircraft Co.'s San Diego plant, has been named assistant plant manager of the company's Des Moines, Iowa, plant.

Philip B. Keller has been appointed vice president in charge of engineering, Stillman Rubber Co.

J. D. Rollins has been appointed vice president-engineering, American Bridge Div., United States Steel Corp.

Floyd V. Snodgrass has been elected vice president in charge of production, Walworth Co.

R. S. Sheldon has joined Whirlpool Corp. as ceramics engineer in the Research and Development Div.

Howard M. Dess has been made senior research assistant in the engineering research group, Metals Research Laboratories, Electro Metallurgical Co., a division of Union Carbide and Carbon Corp.

news of | COMPANIES

Acar Broach Co. has announced the formal opening of a new plant to fabricate metal dies and molds for shaping plastic parts. The new organization, located in Detroit's suburb of Roseville, has been incorpor-

If you MUST stop Corrosion

KEL-F® PLASTIC WILL

KEL-F Plastic Molded and Fabricated Valve Linings, Valve Diaphragms, Gaskets, Ring Seals, Gauge Crystals, KEL-F Dispersion Coated or Laminated Lined Tanks, Vessels, Reactors, Piping and Tubing can protect your plant equipment against chemical corrosion

KEL-F Fluorocarbon Plastic is the best non-permeable, corrosion-proof material available today. It is inert to virtually any type of chemical attack—including mineral acids, oxidizing agents as well as strong caustics. When nothing else will protect equipment, KEL-F Plastic usually will.

HERE ARE SOME OF ITS OUTSTANDING CHARACTERISTICS:

Temperature Tolerance

Exhibits satisfactory properties over a temperature range of approximately 710°F. (−320°F. to 390°F.)

High Compressive Strength

Pressures of 8,000 psi result in only 4% to 5% permanent set. Line seals are retained longer when gaskets and O-ring seals are made of KEL-F Plastics.

Non-Adhesive

KEL-F Plastic is non-wetting even after long periods of immersion. Surface is anti-fouling when in contact with even the most viscous liquids.

KEL-F Plastic is a thermoplastic and easy to fabricate. It is readily molded by extrusion, transfer and injection. Available in sheets, rods, tubing and film, it can be fabricated, heat formed, machined and heat-sealed by a growing list of experienced fabricators.

New! KEL-F Plastic Dispersions

KEL-F Plastic Dispersions have been developed for bake-coating of metallic surfaces that must be corrosion resistant, anti-adhesive and electrically non-conductive. These Dispersions can be applied by spraying, spreading or dipping.

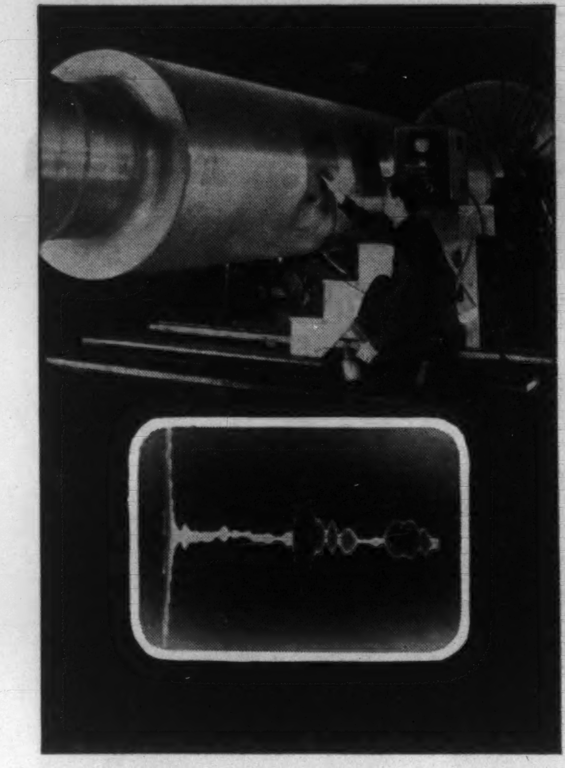
The full story of what KEL-F will do for you is worth having. Write or call for additional information.

THE M. W. KELLOGG COMPANY
Chemical Manufacturing Division,
P. O. Box 469, Jersey City, N. J.
SUBSIDIARY OF PULLMAN INCORPORATED

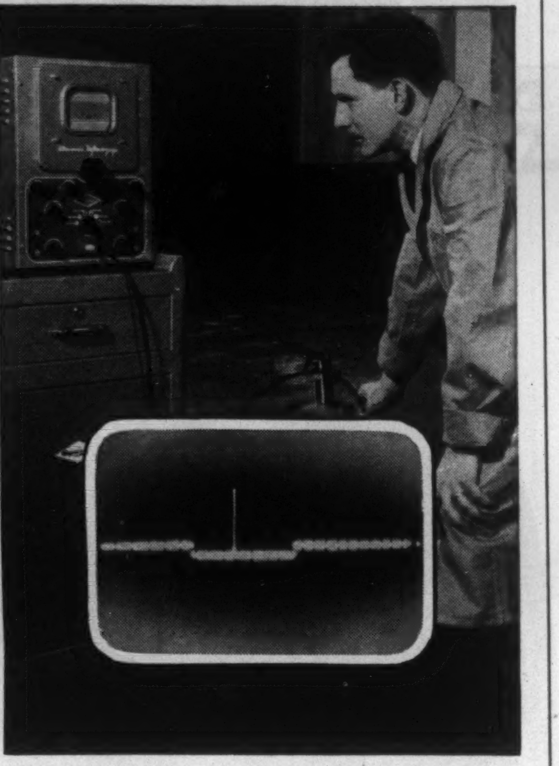
® Registered trademark of The M. W. Kellogg Company's fluorocarbon polymers.

For more information, turn to Reader Service Card, Circle No. 514

TWO SOUND APPROACHES
to new PRODUCTION SAVINGS



SOUND PATTERNS like this on cathode ray tube of Sperry Ultrasonic Testing Reflectoscope saved one company *$1,000,000 in two years.*



SINGLE SHARP SIGNAL for steel-thickness measurement on Sperry Ultrasonic Reflectogage appears against easy-to-read calibrated tape.

through faster, more accurate quality control, better heavy-equipment maintenance

THE SPERRY ULTRASONIC REFLECTOSCOPE

. . . the portable, nondestructive testing instrument that lets you "see"—quickly, accurately, economically—inside metals and other materials, thus enabling you to:

Cut wasted machine and man hours by locating and evaluating both surface and internal defects in your stock materials before expensive machining.

Eliminate costly production delays by discovering fatigue cracks in your heavy equipment before they lead to breakdown.

Speed and improve inspection of your critical finished parts.

THE SPERRY ULTRASONIC REFLECTOGAGE

. . . the new, portable measuring and testing instrument that gives sharp, accurate indications of steel thickness ranging from .014 to .400 inches and offers a fast, economical way to:

Measure thickness of steel sheet where only one surface is available.

Check for lack of bond.

Test stock materials for laminar-type defects.

Assure uniform quality while saving time, labor and material in sheet production and processing operations.

SPERRY PRODUCTS, INC.
Leader Since 1928
in Nondestructive Testing

Like to know more? Simply fill out and mail the coupon below. We'll send you free copies of our two new technical bulletins giving full details.

Sperry Products, Inc.
405 Shelter Rock Road, Danbury, Conn.

Please send me a copy of your new Technical Bulletin giving full details on the:

☐ Sperry Ultrasonic REFLECTOSCOPE (Materials to be tested..)

☐ Sperry Ultrasonic REFLECTOGAGE (Materials to be tested..)

☐ Have your representative call. ☐ Tell me how to arrange for free showing of 10-minute, 16mm sound-color film explaining theory and application of ultrasonic testing.

MAIL NOW

Name..

Title..

Company..

Street..

City.......................... Zone......... State..........

See catalogue 1h-Sp in Sweet's 1955 Plant Engineering File.

For more information, turn to Reader Service Card, Circle No. 473

ated under the name, Acar Die & Mold Engineering Co.

Allied Chemical & Dye Corp.'s National Aniline Div. has announced plans for construction of a multi-million-dollar plant to produce organic isocyanates at Moundsville, W. Va.

Aluminum Ltd. has made plans to more than double the capacity of Canada's aluminum smelter at Kitimat, British Columbia, at an estimated cost of $190,000,000.

American Crucible Products Co. has completed a new building to be devoted entirely to experimental work.

Assembly Products, Inc., has moved to a larger plant in Chesterland, Ohio.

Automatic Steel Products, Inc., has sold its wholly-owned subsidiary, the Cleveland Tapping Machine Co., to the **H. P. Townsend Manufacturing Co.** No change in name is contemplated.

The **Babcock & Wilcox Co.** has recently placed in full operation a new quality control laboratory in its Tubular Products Div. In addition, the Atomic Energy Div. of the company has announced plans for the construction of a plant for the manufacture of fuel elements and other reactor core components for the nuclear power industry, to be located near Lynchburg, Va.

Bestway Products, Inc., has officially opened its new plant on Globe Ave., Mountainside, N. J.

Boonton Molding Co. has announced the establishment of a Special Products Div. which offers extensive production facilities to produce plastics products.

The Colorado Fuel and Iron Corp. has begun an improvement program totaling several million dollars for the Wickwire Spencer Div. plant in Buffalo, N. Y.

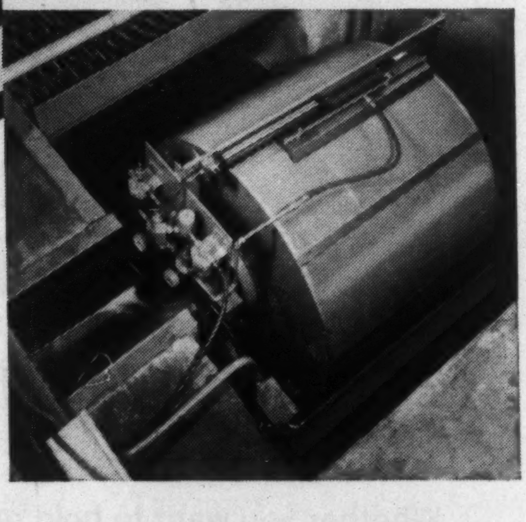
Firth Sterling Inc. has announced plans to acquire the assets of **Houston Carbide Corp.,** Houston, Tex. Houston Carbide will be operated as a division of Firth Sterling.

General Dynamics Corp. has made plans to construct a million dollar research and development center at the Electric Boat Div. for the primary purpose of providing extensive new research and testing facilities in connection with its submarine con-

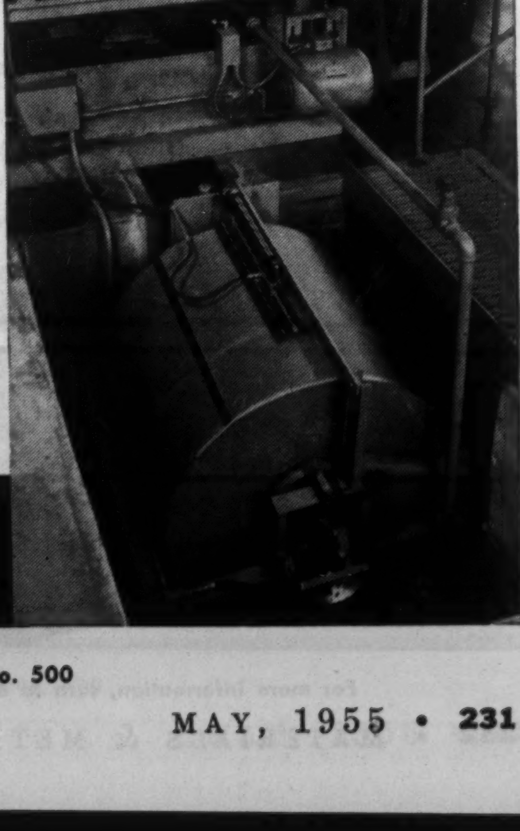
the MURRAY WAY MODEL 10 FILTER

THE AUTOMATIC INDUSTRIAL FILTER THAT RECLAIMS YOUR PRODUCTION DOLLARS

Contaminated coolant enters Model 10 directly from source.



Standard Model 10 with 200 mesh screen removing abrasive grindings from 55 viscous coolant oil in belt grinding operation.



AUTOMATIC—The Murray-Way Model 10 Industrial Filter automatically rotates fresh filtering area into position while simultaneously ejecting the contaminant.

SELF-CLEANING—The permanent filter screen, made in eight sections and screw mounted, is kept clean by the air knife thus giving maximum filtration at all times.

ECONOMICAL—Elimination of costly throw-away media saves you money.

COMPACT—The Murray-Way Model 10 gives you unusually large filtering capacity in proportion to area occupied.

AMAZINGLY ADAPTABLE—The Murray-Way Model 10 Filter may be used as an individual machine unit or as a central filtering station for many units. Capacity may be increased by adding filters in tandem separately or in the same tank.

LARGE SCREEN SELECTION—We can supply filtering screen material and size of screen opening in monel, stainless steel, brass or bronze to meet your requirements.

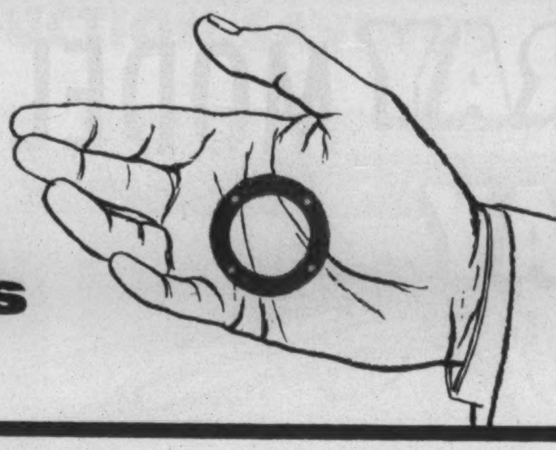
For Complete Technical Details—Write For Bulletin F-5301

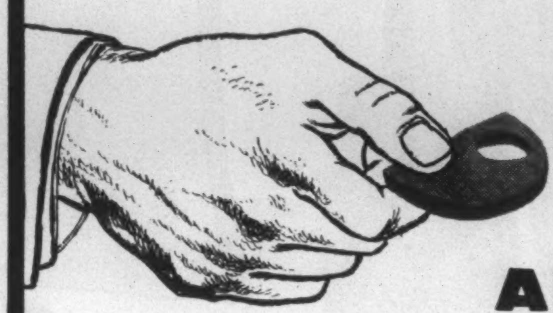
MURRAY WAY

THE MURRAY-WAY CORP.
POST OFFICE RACK 180 • BIRMINGHAM, MICH.
Automatic Polishing, Buffing, Grinding, Filtering Equipment

For more information, turn to Readers Service Card, Circle No. 500

from **Grease Retainers**





to **Air Cleaners**

FELT

BY FELTERS

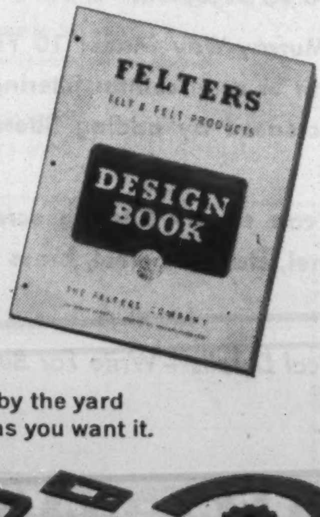
solves your design problems

Whether you want to hold grease in, filter air or provide a wicking method, you'll find the answer in Felt by Felters.

FELTERS S.A.E. F-26 is a felt suitable for packing or padding when held in place by other materials, but is not recommended for mechanical purposes.

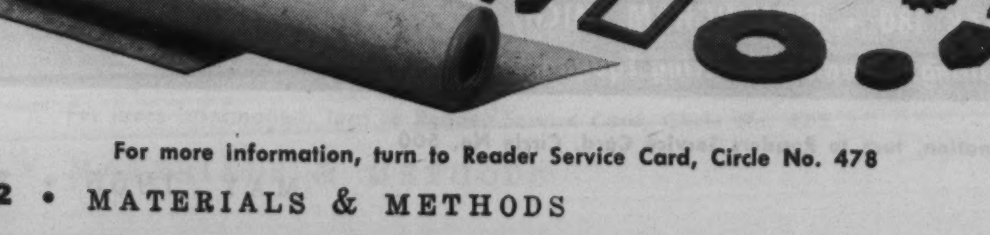
Many types and densities of felt are described in the new Felters Design Book. Write for your copy today.

THE FELTERS CO., 220 South St., Boston 11, Mass.



FELTERS FELT

. . . by the roll . . . by the yard
. . . or cut exactly as you want it.



For more information, turn to Reader Service Card, Circle No. 478

struction program.

Hypro Engineering, Inc., has moved its offices and assembly area to 700 39th Ave. N. E., Minneapolis, Minn.

Joseph T. Ryerson & Son, Inc., a wholly owned subsidiary of Inland **Steel Co.,** has acquired the plant and stocks of **Arthur C. Harvey Co.**

Investment Casting Co. recently announced its new facilities at 60 Brown Ave., Springfield, N. J.

The **Lima Electric Motor Co.** is expanding its main manufacturing plant at Lima, Ohio.

McDowell Co., Inc., has purchased the entire assets and research facilities of **Sintering Machinery Corp.** The enterprise will be known as the Dwight-Lloyd Div. of McDowell.

The **Meehanite Metal Corp.** has announced that a contract to manufacture Meehanite castings has been entered into by the **Nordberg Manufacturing Co.**

Minneapolis - Honeywell Regulator Co. has made plans to construct a new factory building in Chicago.

National Lead Co. has acquired the capital stock of **Southern Screw Co.**

North & Judd Manufacturing Co. has purchased the physical assets, inventories and patents of the E. A. Bessom Corp.

Olympic Metal Products Co., Inc., has completed a 100% expansion in plant facilities at Alpha, N. J. The space will be used almost exclusively in the production of deep drawn metal housings.

The **Pacific Moulded Products Co.** has acquired the assets of **Pacific Moulded Products Co.**

Pennsylvania Salt Manufacturing Co. has announced the incorporation of a new, wholly-owned subsidiary in Calvert City, Ky., to be known as Calvert City Chemical Co.

Philamon Laboratories Inc. has acquired a new plant at 90 Hopper St., Westbury, Long Island, N. Y.

Pittsburgh Plate Glass Co. has executed an agreement providing for the purchase of **Barreled Sunlight Paint Co.,** which will continue to operate under its own name as a wholly-owned subsidiary of Pittsburgh Plate Glass.

Robertshaw-Fulton Controls Co. has announced that the new $2,000,000 plant of the Bridgeport Thermostat

Bundy solves refrigeration problem with unique tubing strainer design

Read how Bundy Engineers work with designers to help make better products

As a designer, you undoubtedly know that Bundy is the leading manufacturer of small-diameter steel tubing. You've probably seen it specified many times.

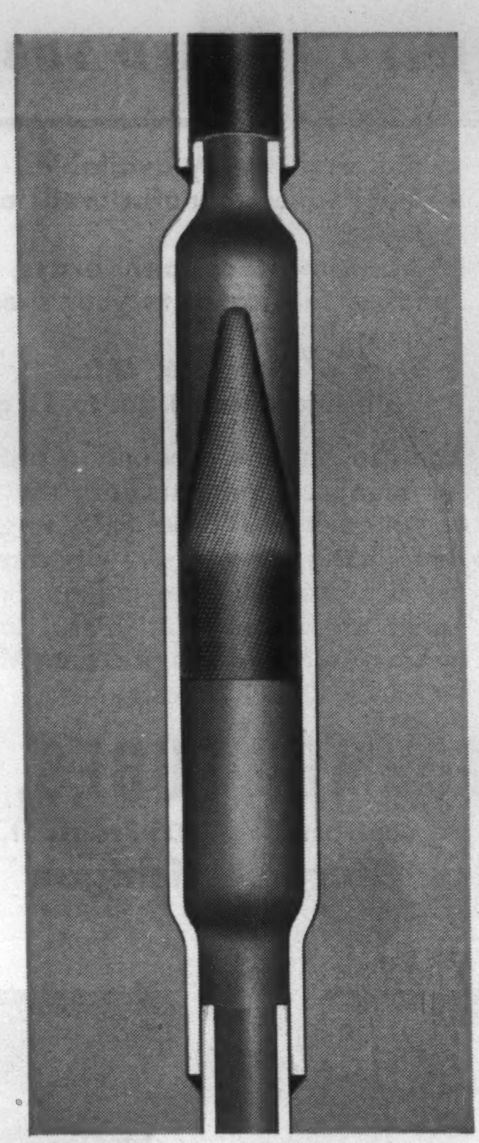
But, for *you,* there is more than manufacturing going on at the Bundy Tubing Company.

Shown at the right is a typical example of the help you can get at the design stage of your product. It is just one of hundreds of contributions which have been made by our engineering staff, in many widely diversified fields.

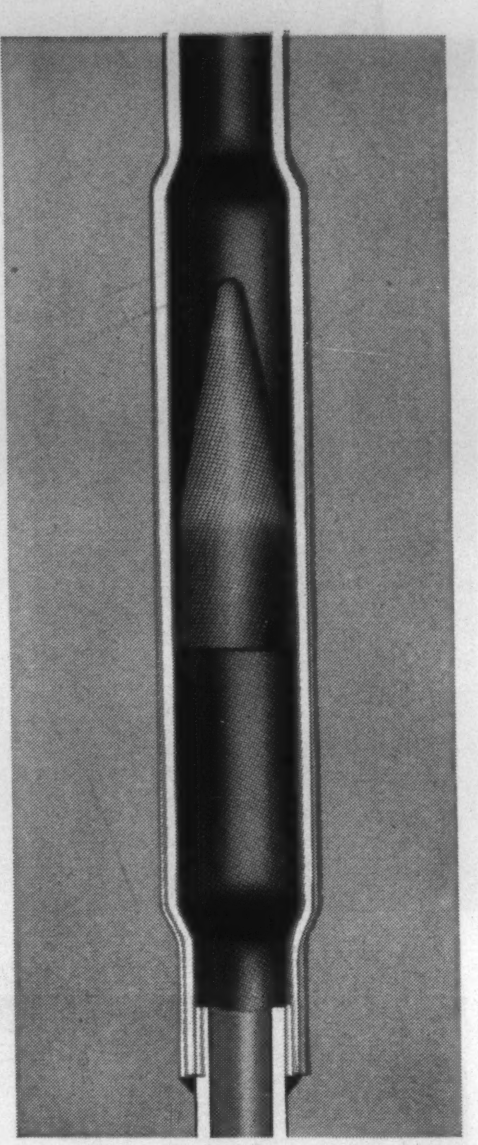
Take advantage of this unbeatable Bundy combination: expert, free engineering service plus genuine Bundyweld Tubing, the only tubing double-walled yet stronger; has high thermal conductivity, high bursting strength; takes easily to any fabricating operation. It is the safety standard of the refrigeration industry, *and is used in 95% of today's cars, in an average of 20 applications each.*

Let Bundy help you with that tubing design problem. Call, write, or wire us today:

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



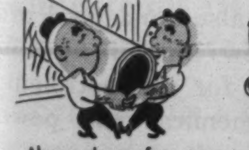
Problem: Because refrigeration systems can be quickly ruined by dirt particles which lodge in capillary tubes, most systems use a separate strainer assembly, as shown above. The two extra solder joints used to install the strainer assembly give rise to an even greater problem—leakage. Expensive hand assembly methods also frequently introduce dirt into the system.



Solution: New Bundy design actually makes strainer an integral part of condenser coil. The coil end is expanded to receive the strainer or filter and then swaged down to capillary size. This ingenious design eliminated one solder joint with its consequent risk of leakage or dirt inclusions; resulted in a cost savings of 50% to the customer.

Bundyweld starts as a single strip of copper-coated steel. Then it's

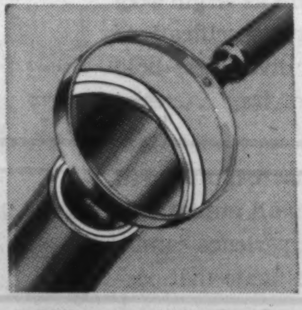
. . . continuously rolled twice around laterally into a tube of uniform thickness, and passed



through a furnace. Copper coating fuses with steel. Result . . .

SIZES UP TO ⅝" O.D.

Bundyweld, double-walled and brazed through 360° of wall contact.



NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

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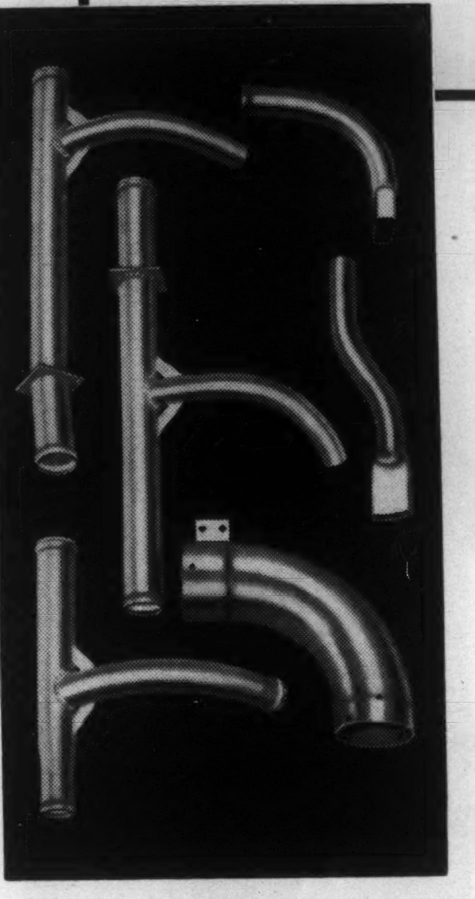
For more information, turn to Reader Service Card, Circle No. 375

SPEED UP YOUR
PRODUCTION SCHEDULES
WITH FORMED TUBES



- ★ Material readily available.
- ★ Steel tubes manufactured to your order.
- ★ Aluminum, copper, brass, steel tubes fabricated to your specifications.
- ★ Sizes 3/8" O.D. to 6" O.D.
- ★ Wall thickness 20 ga. to 11 ga.

You can put the production problems for many components into the hands of your Formed Tubes Sales Engineer. Raw materials and scrap become his worries. You can depend on Formed Tubes to cut costs and make delivery on time. Write for Engineering Manual on Formed Steel Tubes.

FORMED TUBES, Inc.
Contract Div., 505 Prairie St.
Sturgis, Michigan

Need Materials for
1. Oil Seal
2. Oil Wick
3. Stop Vibration
4. Absorb Sound

FOR ALL FOUR
YOUR BEST
ANSWER IS
Felt

Western Felts can be made as soft as virgin wool or as hard as bone—or any desired specifications in between. But always, their live fibers hold their shape. They never ravel or fray . . . resist wear, age, and weather.

For over 56 years Western Felt has manufactured and cut specification felts for all industries. Whatever your problem, our experience can be helpful. Let our engineers investigate that possibility for you.

MANUFACTURERS AND CUTTERS
OF WOOL FELTS

WESTERN Felt WORKS
4021-4139 Ogden Ave
Chicago 23, Illinois
Branches in all Principal Cities

For more information, turn to Reader Service Card, Circle No. 510

news of | COMPANIES

Div. will be ready for occupancy in July.

St. Regis Paper Co. has acquired **Michigan Molded Plastics,** Inc., as a subsidiary.

Sandvik Steel, Inc., is building a new plant in Fair Lawn, N. J., which will consolidate the company and its four divisions in one central location.

Silicone Seals, Inc., 3125 Milwaukee Ave., Chicago 18, Ill., has announced its incorporation to engage in the design and production of silicone rubber hermetic terminals.

Solar Aircraft Co. has announced the formation of a new British corporation, to be known as Sugg Solar Ltd., to manufacture and market Solar's "Mars" gas turbine engines. The new company will be owned jointly by Solar and **William Sugg & Co. Ltd.**

Tensolite Insulated Wire Co., Inc., has announced completion of new plant additions that have doubled production capacity.

Linde Air Products Co., a division of **Union Carbide and Carbon Corp.,** has announced that construction of two new buildings is now under way for the purpose of increasing its laboratory facilities.

Washington Steel Corp. has authorized the installation of a 48-in. Sendzimir cold rolling mill, together with suitable collateral facilities, for the production of stainless steel sheet and strip.

The Schneider Manufacturing Corp., a wholly-owned subsidiary of the **Westinghouse Electric Corp.,** has been dissolved to form the Hydraulic Drives Department of Westinghouse Gearing Div.

Yale Rubber Manufacturing Co. has opened a new plant in Kincardine, Ontario, Canada, to be known as Yale Rubber Manufacturing Co. of Canada, Ltd.

American Locomotive Co. recently announced it has acquired the Carter Craft fin tube process, a new method of heliarc welding longitudinal fins to tubes for use in heat exchangers. It has also announced production of a new line of fin tube heat exchangers for the petroleum, chemical, petrochemical and power industries.

Chrysler Corp. has launched a multi-million-dollar construction program

YOU ARE LOOKING AT ONE THING

Corrosion

CAN'T TOUCH

It is a sheet of Tygon plastic. Flexible enough you can fold it in your hand. Tough enough to outwear leather many times over. It shrugs off with equal ease — both acids and alkalies.

How is it used? In many ways. In sheet form as a protective lining for tanks containing corrosive chemicals; or as gasketing in critical sealing operations. Far more resistant to chemical attack than rubber, far easier to install, Tygon possesses the unusual property of being neutral, neither affecting nor affected by the vast majority of industrial chemicals.

As tubing — in bores ranging from .120″ to 2″ — Tygon pipes acids, alkalies, pharmaceuticals, beverages, milk, liquid foods, blood plasma — highly critical and sensitive solutions — in perfect safety. Glass clear, flexible as a piece of string, Tygon Tubing is the standard of research laboratories the world over.

As a liquid Tygon serves both as a paint and as a dip coating. Applied by brush or spray, it protects metals and concrete from attack by acid fumes.

Tygon molds as readily as rubber, and in this form extends its protective qualities over an almost unlimited range of intricate shapes.

If corrosion is a problem to you — Tygon may prove the perfect answer.

WRITE FOR THIS FREE TYGON PORTFOLIO

Detailed technical data on the use of Tygon in its various forms, arranged in a convenient reference binder.

Address: The U. S. Stoneware Company
Plastics and Synthetics Division
Dept. MM-555
Akron 9, Ohio

Ask for the TYGON PORTFOLIO.

PRODUCT OF

U.S.

STONEWARE

Akron 9, Ohio

Plastics and Synthetics Division

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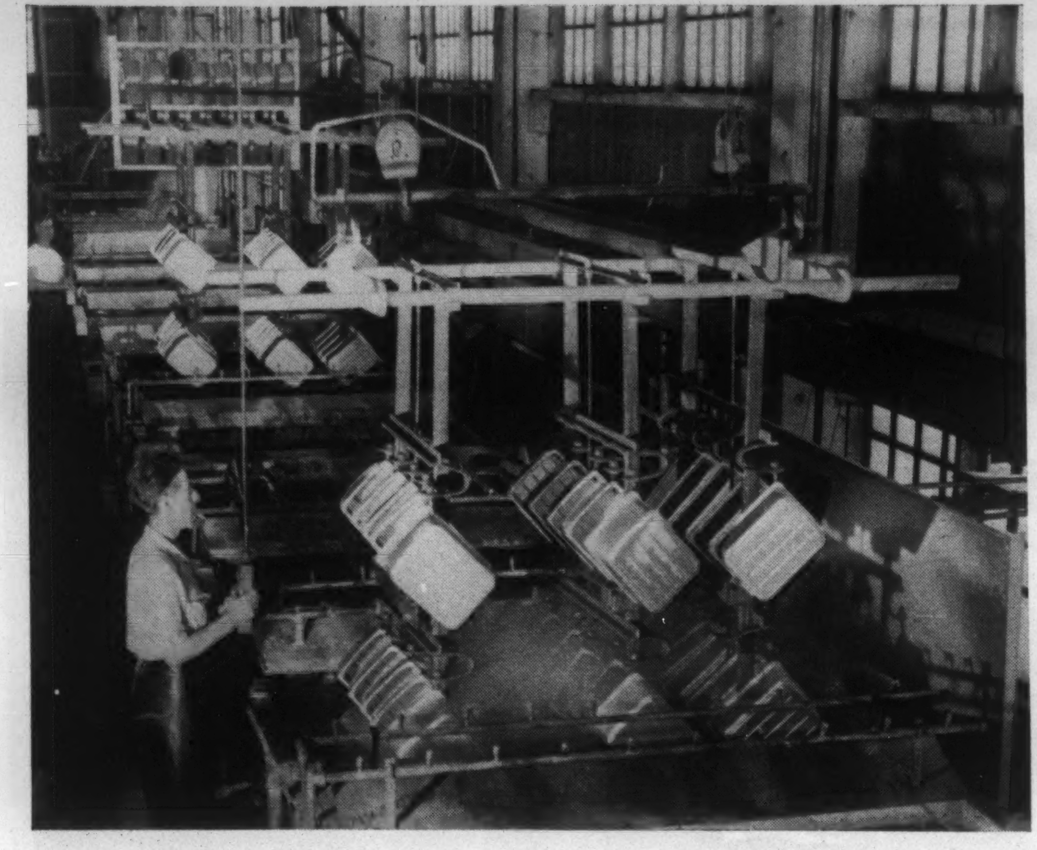


Scale-Free Etching Process produces uniform satin finish for anodic coatings

The key to attractive aluminum products is the etch prior to anodic coating. Whether you are working with clear or colored coatings, an even satin finish without variations from section to section will always guarantee a finished product with high "buy-appeal".

The Aluminux process, developed by The Diversey Corporation of Chicago, is the best method known of consistently delivering a uniformly etched surface with a diffused reflection. Anodic coatings following Aluminux etching inevitably bring out the brilliance of the aluminum without distracting differences in color and texture.

Another unusual characteristic of Aluminux is its ability to hold exceptional quantities of alumina in solution. Tests have shown that it will hold as much as 2000 pounds of scale-forming alumina in a 1000 gallon tank. You can easily see what this kind of prevention of cement-like scale on tank and coils means in reducing heating and maintenance costs.

By reacting uniformly and rapidly with aluminum surfaces, Aluminux eliminates surface variations and produces an even etch in shorter etching cycles. This faster etching speeds up production. In addition, the degree of etch is easily controlled by varying the concentration of Aluminux, the time of etching and/or the temperature.

With the big emphasis on better product appearance and lower costs, it will pay to look into Aluminux. For more information write to The Diversey Corporation . . . 1820 Roscoe Street . . . Chicago 13, Illinois.

For more information, turn to Reader Service Card, Circle No. 490

news of | COMPANIES

for expansion of its engineering facilities.

Dreis & Krump Manufacturing Co. has completed and equipped a new manufacturing building in Chicago.

The **Electric Controller & Mfg. Co.** has moved to 4500 Lee Road, Cleveland 28, Ohio.

Grin Automotive Products Co., a division of **Grin Chemical Corp.,** recently started construction of a $415,000 manufacturing plant and office building in Riverside, Calif.

The **Indiana Steel Products Co.** has acquired the business of the **Ferroxcube Corp. of America.**

Midwest Precision Castings Co. has moved to larger facilities at 10703-09 Quincy Ave., Cleveland, Ohio.

Panellit, Inc., has acquired **Jordan Electronic Mfg. Co., Inc.** The latter company will be operated as a wholly-owned subsidiary of Panellit.

Pennsylvania Fluoro Plastics Co. has recently been formed to supply Teflon tubing for application in the electrical, chemical, petroleum and aircraft fields.

Vickers Inc. has announced plans for construction of a new engineering and administration building in suburban Detroit.

news of | SOCIETIES

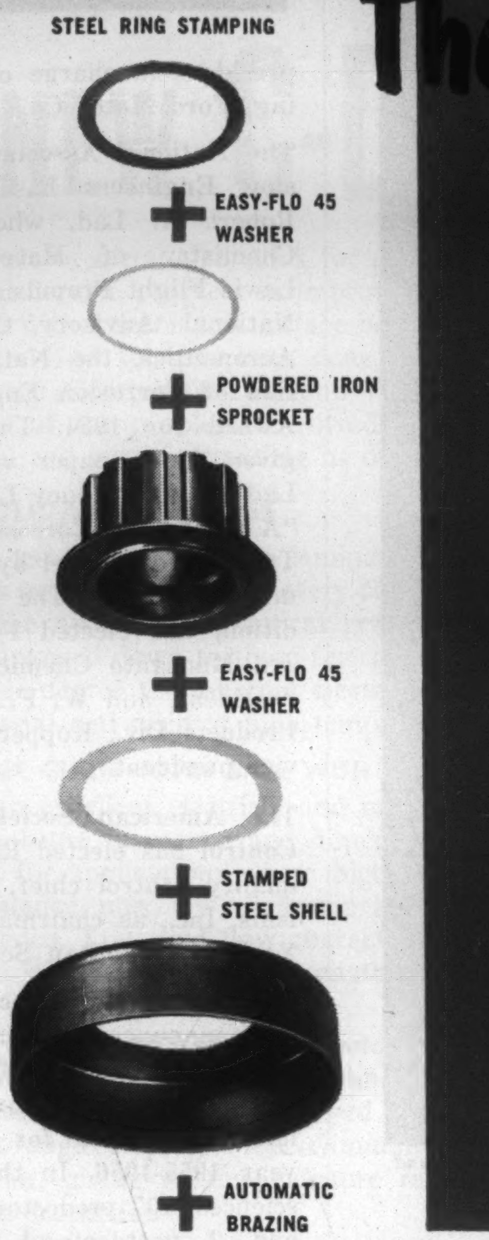
American Society for Metals has appointed Anton deSales Brasunas, associate professor of metallurgical engineering, University of Tennessee, to the post of director of educational activities in the Society's recently-created Metals Engineering Institute. In addition, the Society announced that John F. Tyrrell has been made senior associate editor for its publication, *Metal Progress.*

The **Iron and Steel Institute of Great Britain** has awarded Dr. John Chipman, head of the Department of Metallurgy, Massachusetts Institute of Technology, the Bessemer Gold Medal for 1955; this is England's highest award for outstanding achievement in the science of metallurgy.

The **American Society of Tool Engineers** has elected D. J. Davis to membership in the ASTE Research Fund Committee. Mr. Davis is vice

The EASY-FLO equation

...for strong, low-cost metal joining



Left: Induction brazing fixture with table in loading position. Air valve raises table to brazing position (right). Both joints are brazed at same time.

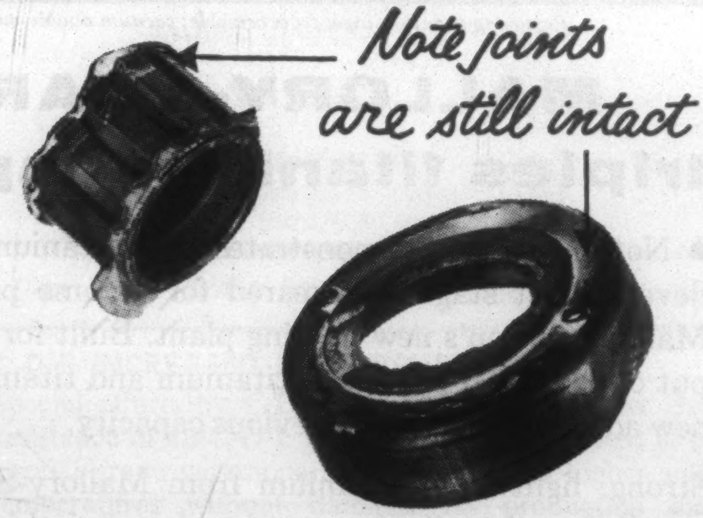
= CLUTCH DRUM ASSEMBLY

PREPLACING THE ALLOY, plus a fast handling and heating setup — that's the EASY-FLO low-temperature silver brazing equation for fast, economical production of virtually indestructible metal joints.

A TYPICAL EXAMPLE is the clutch drum of the HOMELITE Model 17 Chain Saw — noted for its go-power to cut fast without forcing or jamming. At left you see how this drum is produced. Parts and EASY-FLO 45 washers are assembled, Handy Fluxed and induction brazed with a time cycle per assembly of *only 24 seconds.*

. . . and how's this for STRENGTH?

The manufacturer — HOMELITE CORP., reports: *"there hasn't been a field failure in the 5 years the drums have been EASY-FLO brazed."* Considering the rough, tough, stop-go character of chain saw operation, this is convincing proof of the virtual indestructibility of EASY-FLO joints.



Unretouched photo shows one of the assemblies after testing to destruction. Despite the terrific force it took to tear the drum apart, the EASY-FLO 45 joints are still intact. That's typical EASY-FLO brazed STRENGTH.

GET THE FULL STORY IN BULLETIN 20

This bulletin tells why EASY-FLO brazing is inherently fast, reliable and economical. It also gives valuable data on joint design and fast brazing production methods. Write for a copy today.

EASY-FLO SIL-FOS

HANDY & HARMAN

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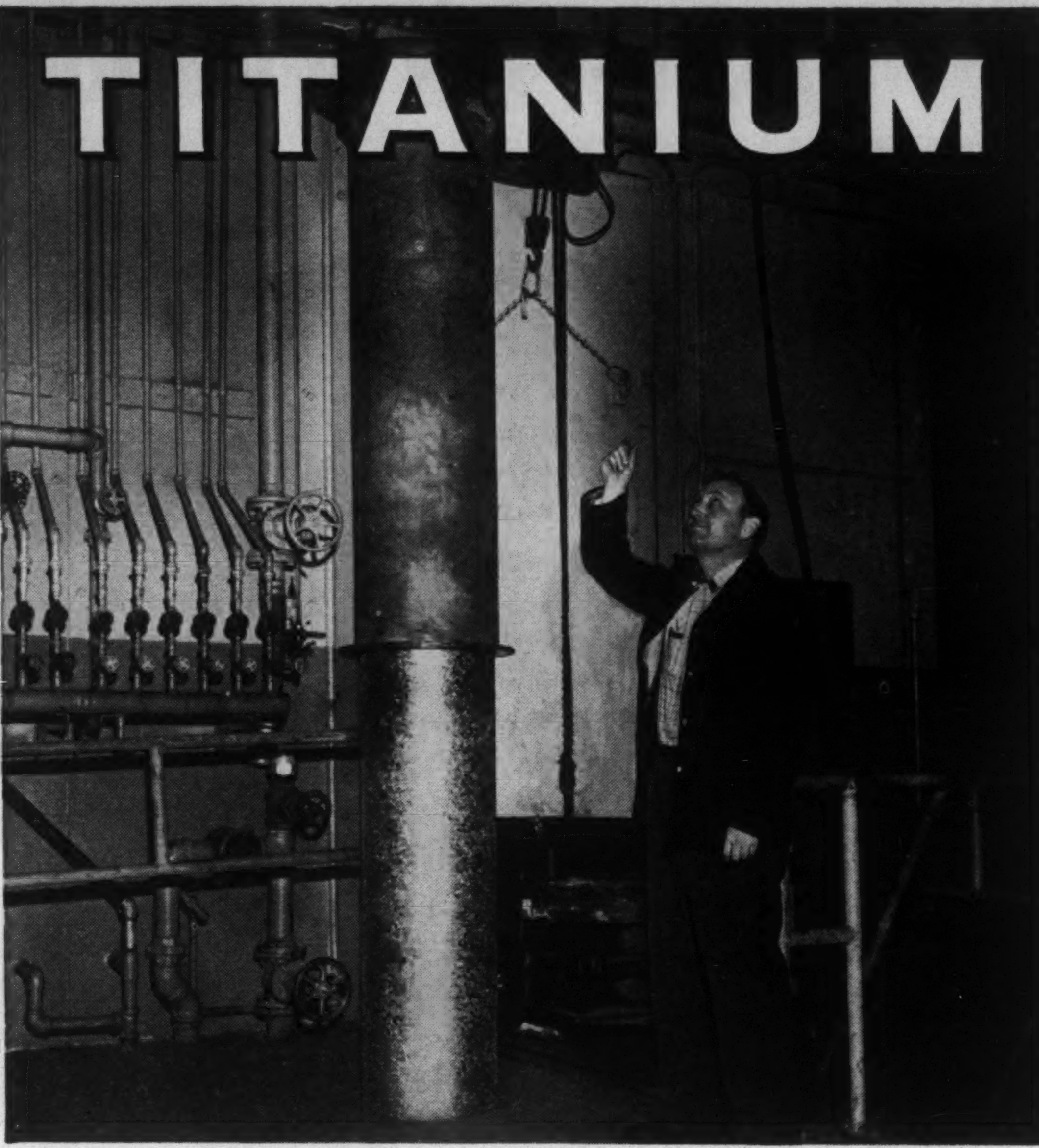
MALLORY·SHARON reports on

TITANIUM



Removing titanium ingot from crucible; vacuum double-melting furnaces in background.

MALLORY-SHARON triples titanium capacity!

• Nothing better demonstrates that titanium is out of the development stage and geared for volume production than Mallory-Sharon's new melting plant. Built for an annual output of 3,000,000 pounds of titanium and titanium alloys, this new addition triples our previous capacity.

Strong, lightweight titanium from Mallory-Sharon is being supplied to virtually every major aircraft and jet engine manufacturer. Its strength and lightness are vital to superior airpower. In commerical applications too, titanium's unexcelled corrosion resistance merits your investigation.

Mallory-Sharon has the production capacity, and even more important, a reputation for the highest quality standards in producing a full range of titanium and titanium alloy mill products. Use our experience in your applications of titanium . . . the new metal that's coming up fast!

Mallory-Sharon Titanium Corporation, Niles, Ohio.

MALLORY Ti SHARON

For more information, turn to Reader Service Card, Circle No. 497

president in charge of manufacturing, Ford Motor Co.

The **National Association of Corrosion Engineers** has presented to Robert A. Lad, who is head of Chemistry of Materials Section, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, the National Association of Corrosion Engineers Junior Award for 1954. The award was given for a paper written by Dr. Lad and Dr. Sidney L. Simon titled, "A Study of Corrosion and Mass Transfer of Nickel by Molten Sodium Hydroxide." The NACE, in addition, has elected F. L. Whitney, Jr., Monsanto Chemical Co., as its president, and W. F. Fair, Jr., Tar Products Div., Koppers Co., Inc., as vice president.

The **American Society of Quality Control** has elected Robert R. Pero, quality control chief, Servomechanisms, Inc., as chairman of the New York Metropolitan Section.

The **National Science Foundation** has announced the award of 715 predoctoral graduate fellowships and 70 postdoctoral fellowships in the natural sciences for the academic year 1955-1956. In the engineering sciences, 107 predoctoral fellowships and 2 postdoctoral awards were made.

The **United States Atomic Energy Commission** has awarded the Commission's Certificate of Distinguished Service to Roy B. Snapp in recognition of outstanding performance of duty with the AED and its predecessor, the Manhattan Engineer District, Corps of Engineers, U. S. Army.

The **Society for Nondestructive Testing** has presented an honorary life membership to Dr. Kent R. Van Horn, director of research, Aluminum Co. of America.

The **National Electrical Manufacturers Association** has awarded S. Wyman Rolph, retired president of the Electric Storage Battery Co., the NEMA 50-Year Certificate in recognition of his half century of service in the electrical industry.

(Meetings & Expositions on p. 240)

Coming in July
How to Choose Wrought Steels
A Materials & Methods Manual

Get better printed circuits . . . lower costs . . . fewer rejects

with NEW C-D-F METAL CLADS

All manufacturers of metal clad stock for printed circuitry have made considerable progress in improving their product—a material with a metal foil surface bonded to a nonconducting base. How this has been done by one leading manufacturer, the Continental-Diamond Fibre Company, illustrates some of the problems involved in buying this type of material and in understanding its design potentials.

C-D-F CONSOLIDATED GRADES

At first, small test lots of Dilecto laminated plastic with copper surfaces were made. Almost every core material was used. Finally the number of practical grades for printed circuit work narrowed down to these few grades which retained to a large degree the inherent electrical qualities of their base material and resin at high temperatures:

XXXP-26 COPPER CLAD—PAPER BASE WITH PHENOLIC RESIN

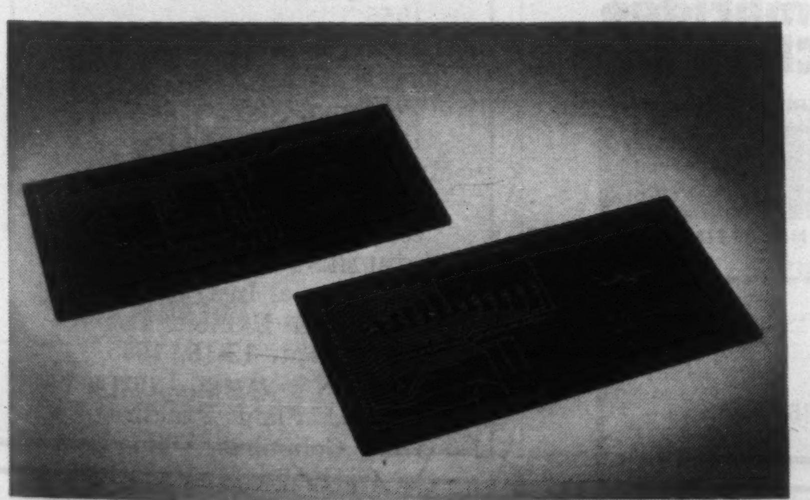
A laminate with excellent electrical and mechanical properties. High moisture resistance and dimensional stability. Recommended for applications where high heat and high insulation resistance plus low dielectric loss under high humidity is needed. Low cold flow characteristics. Can be hot punched to ⅛″. Good flexural strength. Natural green color.

This is one of the *improved C-D-F Dilecto laminates.* Advances in resins and manufacturing techniques make this grade almost homogeneous, with improved impregnation of the filler. Thorough impregnation eliminates entrapped moisture and air, giving greater moisture resistance and better dielectric properties.

Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a *uniform* metal clad material, like this C-D-F grade, becomes vital.

XXXP-24 COPPER CLAD—PAPER BASE PUNCHING GRADE WITH PHENOLIC RESIN

Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.



GB-181E COPPER CLAD—GLASS FABRIC WITH EPOXY RESIN

The new C-D-F epoxy grade uses a glass fabric laminate with a copper foil surface on one or both sides. Epoxy resin laminates possess very high mechanical strength (tensile and flexural), along with good dielectric strength, both perpendicular and parallel to laminations. Used in government and commercial equipment, epoxy metal clads are superior to phenolic laminates in moisture absorption and temperature resistance. Both bond and hot solder tests are rated excellent.

GB-116T COPPER CLAD—GLASS FABRIC WITH TEFLON RESIN

A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

C-D-F INCREASED BOND STRENGTH

By developing a special thermo-setting adhesive particularly suited for metal clads, C-D-F was able to increase the bond strength of their laminates considerably above their original figures. Bond or peel strength, the amount of pull required to separate the foil from the core material, is one of the most important physical properties. Therefore, the purchaser should compare his source of supply with these C-D-F average test values:

BONDING STRENGTH—FOIL TO LAMINATE

MATERIAL	Average or Typical Value Lbs. pull per 1″ width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014″ copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028″ copper	7 to 9
GB-181E plus 0.0014″ copper	15 to 18
GB-116T plus 0.0014″ copper	6 to 9

These values are based on tests at prevailing room temperature (20-30°C.)

C-D-F INCREASED HEAT RESISTANCE

Special efforts by C-D-F technicians to increase the heat resistance of all C-D-F Metal Clads have resulted in certain special grade variations able to withstand higher soldering temperatures without damage. As production methods change, C-D-F offers materials to meet your requirements.

NOW . . . HOW ABOUT YOUR STORY?

Notice how we have talked about C-D-F and what we have done to improve quality and uniformity of metal clad products. Much of this has been accomplished with the guidance and cooperation of leading users of printed circuit stock. No one company knows all the answers . . . but C-D-F, a big reliable source of supply, can help you get better printed circuits . . . lower costs . . . fewer rejects. Look up the address of your nearest C-D-F sales engineer in Sweets Design File, write us for samples you can test in the lab and on the production line, technical bulletins, help on your specific project. We want to work with you!

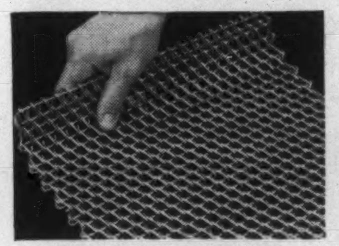
WRITE FOR NEW C-D-F DILECTO CATALOG

CDF *Continental-Diamond Fibre*

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 25, DELAWARE

For more information, turn to Reader Service Card, Circle No. 511

A CHALLENGE TO USERS OF WOVEN WIRE CONVEYOR BELTS



Spec. RR-23-22-12 for use up to 2100°F.

If you use woven wire conveyor belts for continuous heat treating, annealing, sintering or any other operations up to 2100° F, we challenge you to send for this FREE SAMPLE of Cambridge belting—and make these comparisons to any other brand:

Compare the uniformity and flexibility of the non-welded belt; see how the absence of welds permits uniform expansion and contraction of the entire belt under temperature changes. *Compare* the accuracy of mesh count and wire size. *Compare* the spiral formation and note lack of scars or marks on the body of the wire and cross rods. *Compare* its flexibility. And, *compare* even its appearance and its "heft".

Once you've done so, we think you'll agree that Cambridge offers you more . . . because they're made better; that means longest belt life and lowest belt maintenance for you.

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OFFICES IN PRINCIPAL INDUSTRIAL CITIES

THE CAMBRIDGE WIRE CLOTH COMPANY, DEPARTMENT A
CAMBRIDGE 5, MARYLAND

Gentlemen: Please send me my FREE SAMPLE of your belting specification RR-23-22-12.

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Company ____________

Street ____________

City ____________ Zone ____________ State ____________

For more information, turn to Reader Service Card, Circle No. 505

Meetings & Expositions

PORCELAIN ENAMEL INSTITUTE, mid-year division conference. Chicago. May 18-20, 1955.

AMERICAN SOCIETY FOR QUALITY CONTROL, annual convention. New York. May 23-25, 1955.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. Houston. May 23-27, 1955.

I. R. E. MATERIALS SYMPOSIUM. Philadelphia. June 2-3, 1955.

AMERICAN WELDING SOCIETY, Welding Show and Spring Meeting. Kansas City, Mo. June 7-10, 1955.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting, Atlantic City. June 12-17, 1955.

MALLEABLE FOUNDERS' SOCIETY, annual meeting. White Sulphur Springs, W. Va. June 16-18, 1955.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Boston. June 19-23, 1955.

AMERICAN ELECTROPLATERS' SOCIETY, Industrial Finishing Exposition. Cleveland. June 20-23, 1955.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION, annual meeting. State College, Pa. June 20-24, 1955.

INSTITUTE OF THE AERONAUTICAL SCIENCES, international aeronautical conference. Los Angeles. June 21-24, 1955.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City. June 26-July 1, 1955.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, semi-annual meeting. San Francisco. June 27-29, 1955.

AMERICAN NUCLEAR SOCIETY, first annual meeting. State College, Pa. June 27-29, 1955.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Portland, Ore. Aug. 15-17, 1955.

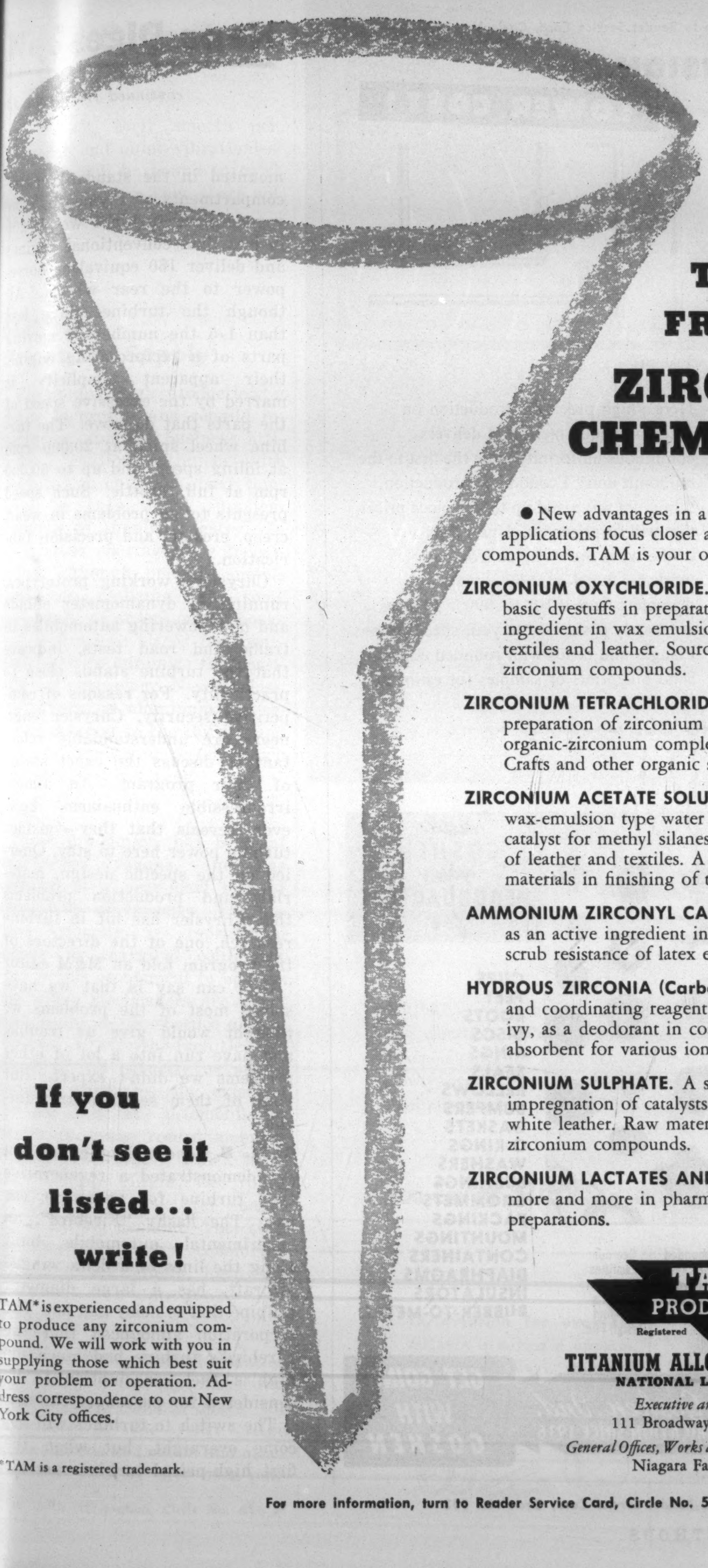
METALWORKING MACHINERY & EQUIPMENT EXPOSITION. Chicago. Sept. 6-16, 1955.

INSTRUMENT SOCIETY OF AMERICA, Annual Instrument Conference & Exhibit. Los Angeles. Sept. 12-16, 1955.

PORCELAIN ENAMEL INSTITUTE, Annual Shop Practice Forum. Columbus, Ohio. Sept. 14-16, 1955.

WORLD PLASTICS FAIR AND TRADE EXPOSITION. Los Angeles. Oct. 5-9, 1955.

ELECTROCHEMICAL SOCIETY, fall meeting. Pittsburgh. Oct. 9-13, 1955.



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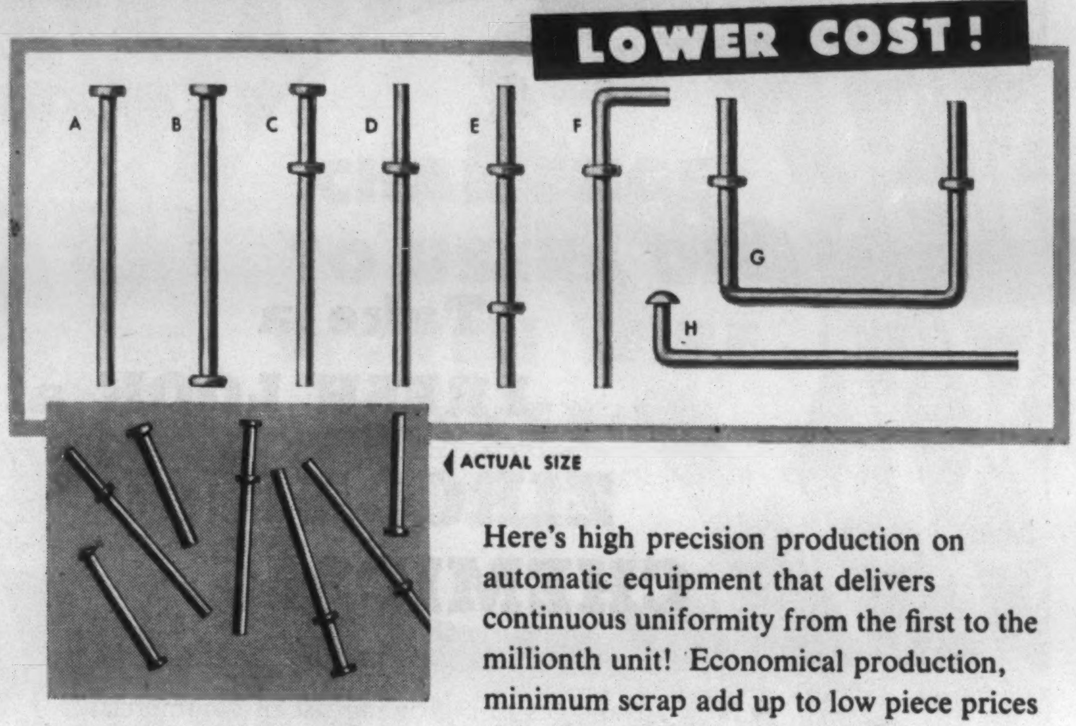

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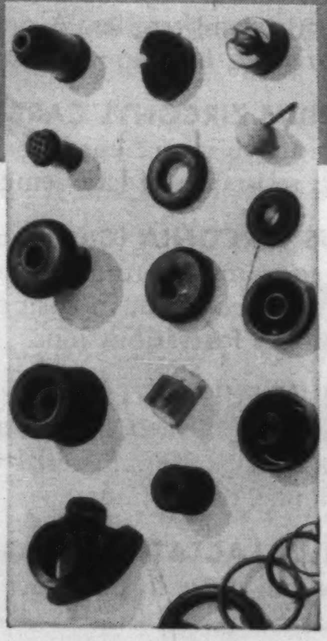

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Producing custom-designed parts, of carefully-compounded materials, is a Goshen specialty. Parts are not stocked, but are fabricated exclusively on order to meet your strictest specifications as to compound, service-life and operating satisfaction. Your inquiry regarding any rubber parts problem is invited.

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GET GOING WITH GOSHEN

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continued from page 13

mounted in the standard engine compartments of Plymouths. The regenerative turbines weigh 200 lb less than conventional engines and deliver 160 equivalent horsepower to the rear wheels. Although the turbines have less than 1/5 the number of moving parts of a reciprocating engine, their apparent simplicity is marred by the excessive speed of the parts that do move. The turbine wheel spins at 20,000 rpm at idling speed, and up to 50,000 rpm at full throttle. Such speed presents tough problems in wear, creep, erosion, and precision fabrication.

Chrysler's working prototypes, running in dynamometer stands and now powering automobiles in traffic and road tests, indicate that the turbine stands close to practicality. For reasons of competitive security, Chrysler engineers are understandably reluctant to discuss the exact status of their program. An almost irrepressible enthusiasm, however, reveals that they consider turbine power here to stay. Queried on the specific design, materials and production problems that Chrysler has hit in turbine research, one of the directors of the program told an M&M editor "All I can say is that we have solved most of the problems we thought would give us trouble, and have run into a lot of other problems we didn't expect. But none of them seem insurmountable."

G. M. ■ General Motors has not yet demonstrated a regenerative type turbine for passenger car use. The flashy "Firebird", an experimental automobile built along the lines of a delta winged aircraft, has a large diameter tailpipe that is noisy and hot. The corporation announced that the Firebird's turbine had much too high a fuel consumption to be considered for passenger car use.

The switch to turbines will not come overnight, but when the first high-priced turbine cars hit

News Digest

the market, their smooth performance and quiet vibrationless operation will be bound to catch the public fancy. Then there will be a scramble to watch.

Materials Prices and Supply

Continuing high production, a desire to protect and rebuild inventories, and the business attitude of "cautious optimism" with emphasis on optimism, have combined to keep metal suppliers jumping to supply industry. In some areas shortages are threatening, although primary metals producers, realizing that some percentage of orders on the books are duplications placed for insurance, tend to minimize the possibility of emergency. Nevertheless, the squeeze in aluminum has renewed interest in the third round primary capacity expansion which was cancelled last year.

Steel

Steel production has been at near-record volume, and has steadied at a near-ideal rate of 90 to 94% of capacity. The unused capacity is represented largely by marginal equipment that is less economical to operate and which steelmakers are reluctant to use in the absence of real trouble. All efficient facilities are going at full capacity or above.

Some shortages do exist in finished steel. The automobile industry in using record amounts of cold rolled sheet, which is in short supply. Light, flat rolled products and structural shapes are in strong demand. Tool steel and fasteners, often considered industrial bellwethers, have had the best season since 1952.

Copper

The nonferrous metal situation is in a state of flux that has shown almost daily changes since the beginning of the year. High copper prices in London and other overseas markets have been pull-

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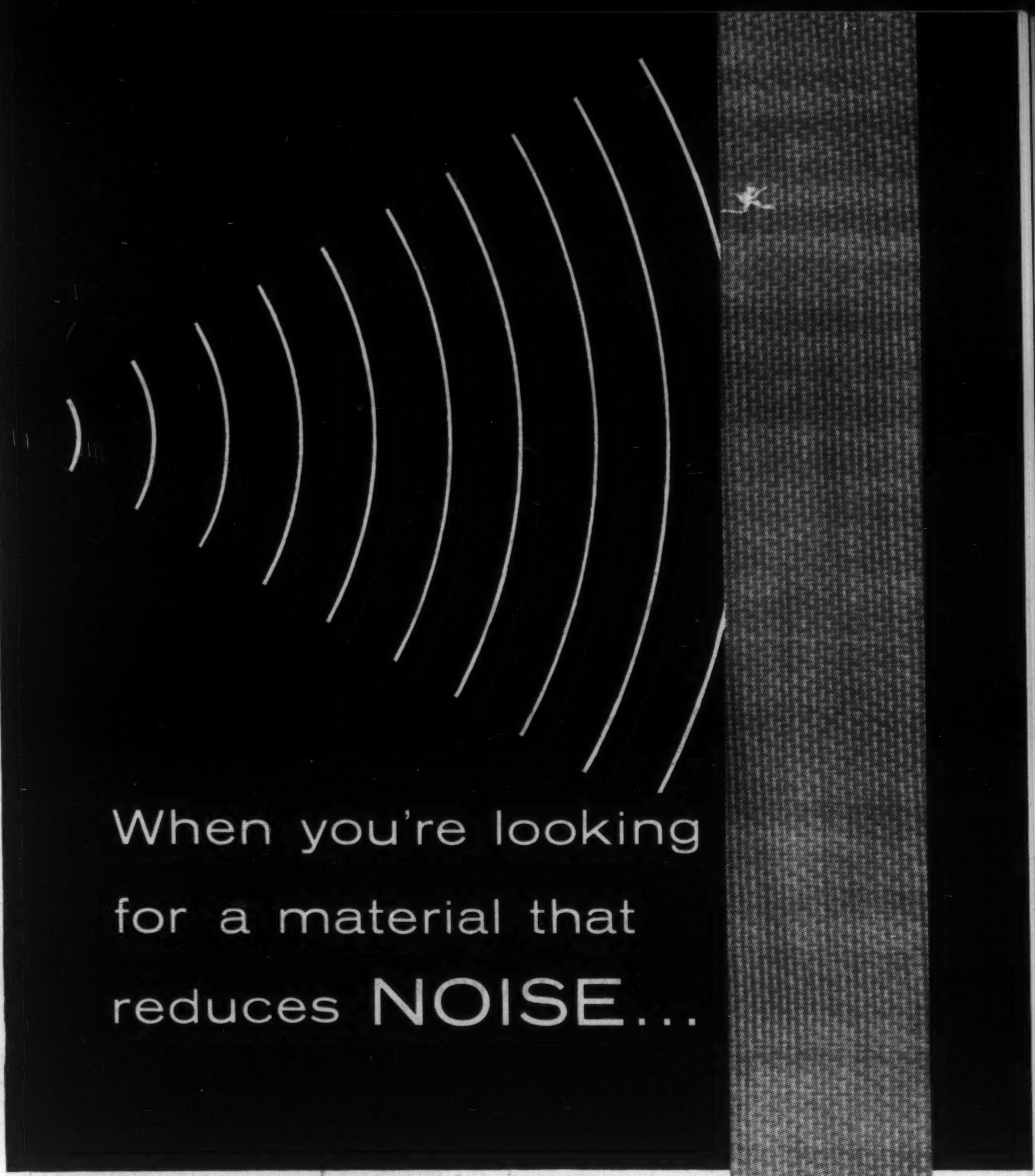

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MICARTA's resilient structure "shushes" noise because it "soaks up" impact and vibration. MICARTA offers high compressive and flexural strength, too. It repels moisture . . . fights corrosion . . . endures heat and cold . . . wears slowly, evenly. How can this amazing material, that does so many jobs better than metal, serve you? Use the coupon for the complete story. J-06582

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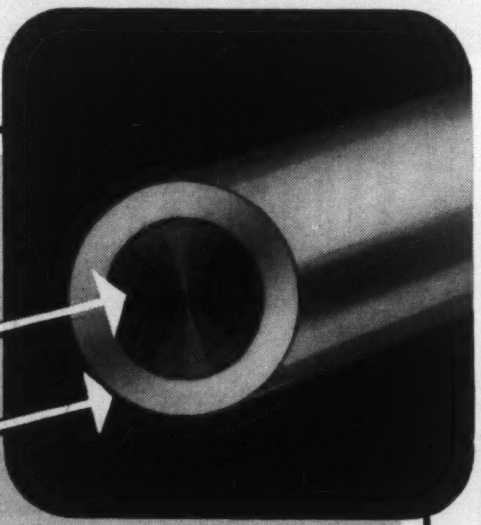

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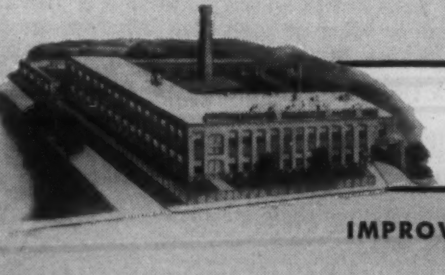

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ing supplies away from American smelters. Despite an embargo on scrap and primary exports, producers here could not hold prices, and the 30¢ ceiling broke in February with a 3¢ increase. The ink was scarcely dry on new price schedules when copper jumped another 3¢ to 36¢ per lb, the highest price for primary copper since 1918.

Zinc

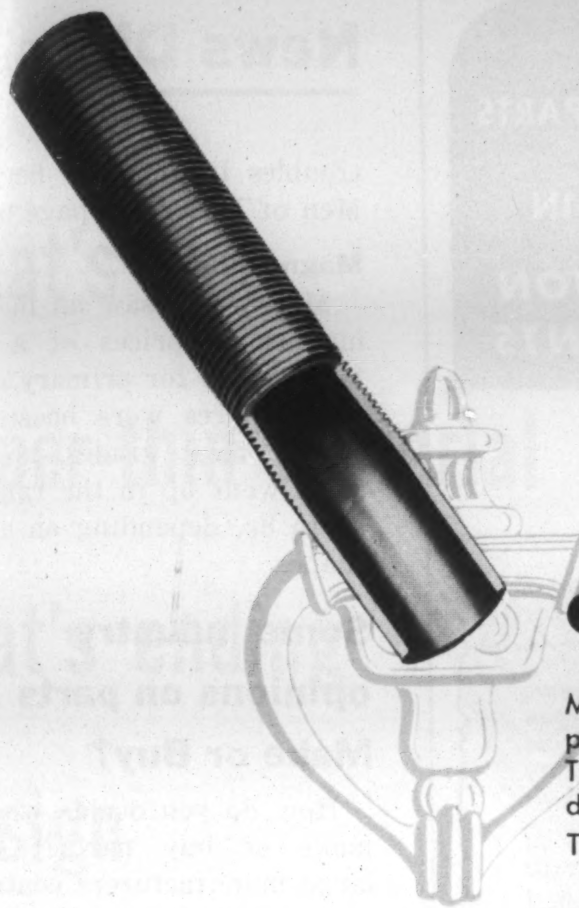
Demand for high quality zinc for die castings continues sharp, with some users reporting shortages. Prime western zinc, the price base grade, is in plentiful supply. Zinc stocks have dropped considerably in the last two months, but the drop is not due to industrial consumption alone. The government has been buying large tonnages for stockpile to keep base prices up.

Aluminum

Aluminum, despite record primary production, is persistently reported in short supply. Demand has not slacked despite the price increase put into effect at the beginning of the year. The market for aluminum is particularly broad at this time with indications that it will continue to spread. Architectural use is up, appliances are using more of the metal, and the automotive industry is using great quantities, particularly for increased production of large die castings for automatic transmissions. The only significant increase in primary aluminum capacity that is meaningful to American consumers is the revised plan to double the output of Aluminium Ltd.'s Kitimat operation.

Titanium

Titanium prices were cut for the third time in a year in March. Du Pont and Titanium Metals, Inc. cut the price of sponge from $4.50 to $3.95 a pound. Part of the reduction may be reflected in lower finished prices for sheet and bar, but titanium's general



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The opportunity knocks twice!

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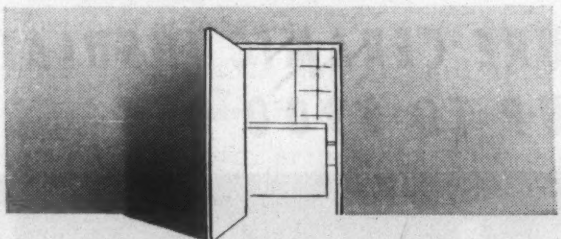
Trufin has fins squeezed right from the tube wall. Fin efficiency stays the same despite the shock of temperature changes, varying pressures or vibration. Trufin is available in a wide range of sizes in copper, copper-base alloys, aluminum, electric-welded steel and bi-metal.

Wolverine's Field Engineering Service can help you with such problems as alloys, design, fabrication techniques.



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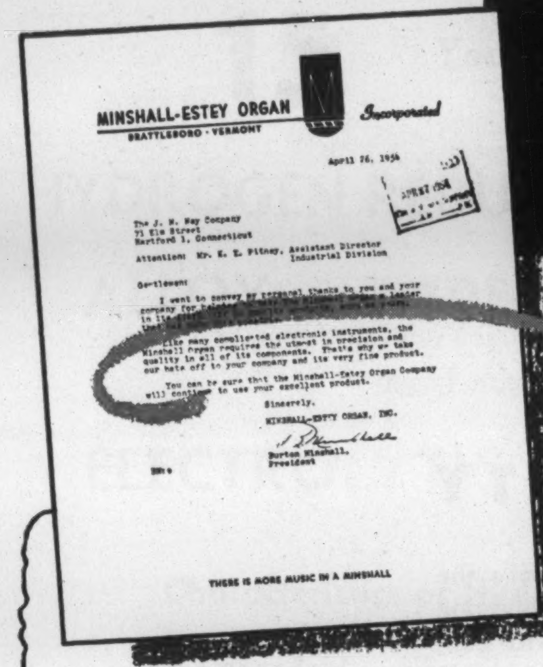

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April 26, 1954

The J. M. Ney Company
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Attention: Mr. K. E. Pitney, Assistant Director
Industrial Division

Gentlemen:

I want to convey my personal thanks to you and your company for [illegible]

Like many complicated electronic instruments, the Minshall Organ requires the utmost in precision and quality in all of its components. That's why we take our hats off to your company and its very fine product.

You can be sure that the Minshall-Estey Organ Company will continue to use your excellent product.

Sincerely,

MINSHALL-ESTEY ORGAN, INC.

Burton Minshall,
President

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"Like many complicated electronic instruments, the Minshall Organ requires the utmost in precision and quality in all of its components. That's why we take our hats off to your company and its very fine product."

With ideal physical and electrical properties, resistance to tarnish and most corrosive atmospheres, Ney Precious Metals, fabricated into slip rings, brushes, wipers, and contacts, have again demonstrated their superiority for use in precision electrical and electronic apparatus. Improve the accuracy and prolong the life of your instrument by using Ney Precious Metal Alloys. Write today to... Engineering Department.

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News Digest

troubles lie in other fields. [See Men of Materials, page 9].

Magnesium

March also saw an increase in magnesium prices of a cent to $1\frac{1}{2}$¢ per lb for primary material. Sheet prices were boosted 3¢ to 5¢ for most grades, and extrusions went up in the range from 2¢ to 8¢, depending on alloy and shape.

Some industry opinions on parts . . . Make or Buy?

How do you decide whether to make or buy parts? Whether large manufacturers contract out or build their own facilities for producing parts and subassemblies can mean life or death for independent foundries, machine shops and parts manufacturers. Spokesmen from several large manufacturers revealed surprisingly different attitudes toward do-it-yourself versus contracting out. The discussion took place at the 1955 Machine Design conference, a joint affair of the ASME and the New York University College of Engineering.

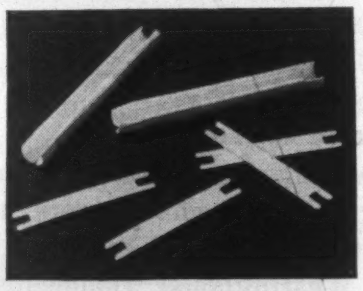
A 20% return?

Westinghouse Electric Corp., according to W. C. Allen, Director of Manufacturing & Equipment Engineering, "shoots for a 20% return on investment as a first criterion". The decision to make a part or buy a part, said Allen, is made entirely on economics. Major factors include: 1) the investment necessary for production equipment; 2) the production space required; and 3) whether additions must be made to the labor force. Allen said that availability is seldom considered as a factor, since Westinghouse expects outside suppliers to fulfill contracts and produce suitable parts if they take on the job.

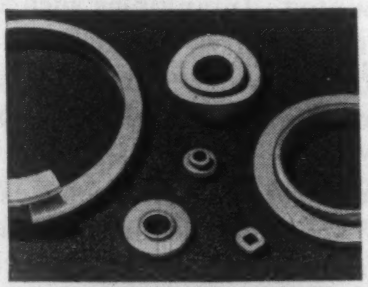
From Caterpillar Tractor Co., W. C. Cadwell, General Supervisor of the Engineering Dept., seconded the criteria of Westinghouse, although he did not specify a percentage savings. Chrysler

what's this paper-thin material that's ending design problems?

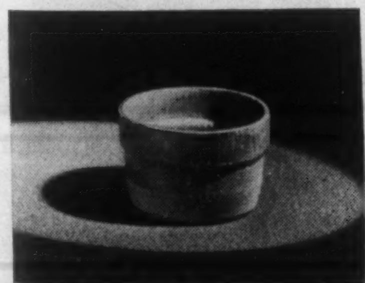
Thin Fibre supports man's full weight. These corrugated sheets are used in duct forms for cooling electrical transformers—where a combination of good electrical properties, high mechanical strength and rigidity is essential.



Suture Reels for Surgical Use must withstand immersion in alcohol or formaldehyde until used. Easy forming, slitting and chemical inertness are other advantages of vulcanized fibre.



An Endless Variety of Washers and other punched parts can be made from vulcanized fibre. Machining steps include forming, punching, shaving, swedging, contouring.

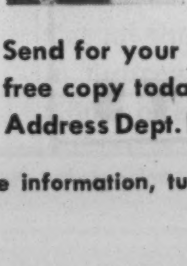


Retaining Cups of Vulcanized Fibre are used to hold in place other insulating materials or adhesives. Easily drawn from thin fibre, these cups replace expensive molded plastic parts.

You've seen it before in critical applications. You may even have used it yourself without realizing its full potentials. Since 1873, its unmatched combination of properties has unscrambled thousands of design puzzles.

It's far more than an insulating material—although you can't buy a better insulator at the price. It's one of the strongest materials known—per unit of weight. It's tough, hard, resilient, resistant to wear and corrosion, and weighs only half as much as aluminum. And it's easy to draw, form or machine to virtually any shape.

Its name is *National Vulcanized Fibre*—the original time-tested plastic. Its uses are legion. Besides the parts shown here, it goes into such rough-duty products as textile-shuttle armor, abrasive discs, athletic guards, rail joint insulation, gears and cams. If there's a design problem defying you, learn how to lick it with this versatile material. Our new 16-page General Catalog—considered a handbook for designers—is yours for the asking.



Send for your free copy today. Address Dept. D-5.

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WILMINGTON 99, DELAWARE

In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

Also Manufacturers of Peerless Insulation, Vul-Cot Wastebaskets, Materials Handling Receptacles and Textile Bobbins.

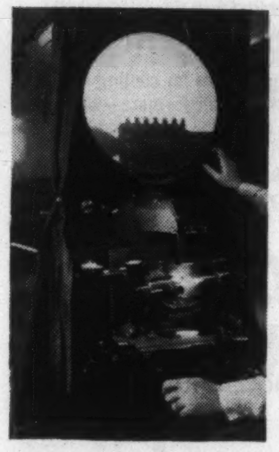
For more information, turn to Reader Service Card, Circle No. 513

3 EASY WAYS to boost production of precision parts

Cut costs, speed inspection, with understage illumination

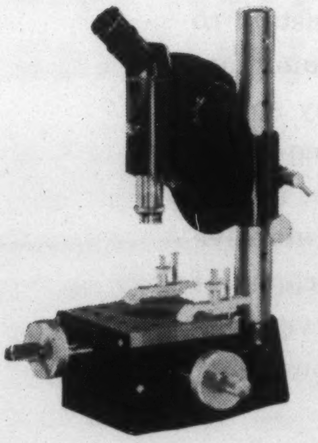
① Bausch & Lomb BENCH COMPARATOR

Save inspection costs: no expensive holding fixtures needed for most work. Save time: no complicated set-up. Easy operation quickly provides vivid screen image, reveals costly production errors. Micrometer stage (optional) reads to .0001″.



② Bausch & Lomb CONTOUR MEASURING PROJECTOR

Quickly, easily shows sharp silhouettes or detailed surface views on 18″ screen . . . for inspection, comparison, or highest precision measurements. Linear readings to .0001″; angular, to 1 minute of arc.



③ Bausch & Lomb TOOLMAKERS' MICROSCOPE

Quickly measures or inspects opaque or transparent objects of any contour. Linear readings to .0001″; angular, to 1 minute of arc.

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BAUSCH & LOMB
SINCE 1853

Quality Control
INSTRUMENTS

Corp. makes it a practice to purchase all possible components from vendors rather than undertaking in-plant production, according to A. J. Langhammer, President of Chrysler's Amplex Div.

Makes special equipment

Henry Michaelson, of the New Departure Div. of General Motors Corp., limited his answer to the question of buying or making tools for production. New Departure will buy any commercially available equipment that meets its needs, he reported, but if special machines are needed for New Departure, they will do their own development and machine construction to keep competitors from using the idea for as long as possible. If such special tools are suitable for use in other GM divisions, they are likely to be designed, developed and built in the Central Development Div. in Detroit.

Automatic considerations

Answering a question from the floor regarding changeovers to automatic control equipment, Allen of Westinghouse commented that it was always a question of cost, but that savings on man-hours were not the only cost to be accounted. Intangibles such as improved quality, reduction in product variation, and better labor conditions and relationships with personnel, as well as reduced scrap and reject loss, frequently lead to an economic saving that pays off handsomely even though the first cost of equipment appears far out of line.

Tool design

Allen emphasized the economies possible through substituting high efficiency equipment for existing high cost tools. He cautioned the machine tool industry to pay more attention to the study of materials weight-strength relationships in designing new tooling. "Some equipment is too massive and heavy for its operating purposes", Allen said. "Other ma-

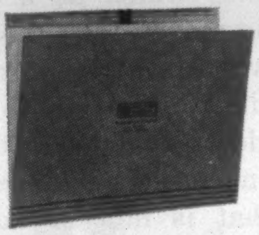
Remington Rand INC

BETTER BUSINESS METHODS

For Greater Profits
Through Lower Costs

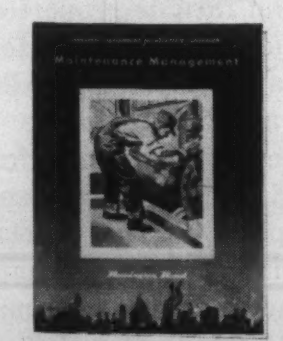
Efficient and Inexpensive Purchase Order Follow-Up Clicks at Libby-Owens-Ford

This Company processes open purchase orders with a minimum of confusion, executive time and expense, by using signalled Visible Tip Follow-Up Folders with printed date scales. All orders are followed up automatically by clerks on signalled dates. Folders are filed by vendor's name for easy reference, yet the visible signals make follow-up easy. Kardlok signals lock into position for positive control, yet can be changed easily. The same folders are used hundreds of times and the same clerk handles a given order for its entire "open" life. This system covers any application where follow-up is essential. See LBV567 Rev. 1.



Sound Maintenance Plan Slashes Costs; Assures Equipment Productivity

Folder X1383 Rev. 1 describes graphically a Maintenance Control System that is currently cutting maintenance costs while boosting equipment productivity in many well known plants. This Plan fulfills the five *must* requirements of any workable maintenance control system, including *written work orders, scheduled work, equipment records, stores control* and *executive reports.* Read about it in X1383 Rev. 1.



Effective Machine Loading System for Maximum Return on each Production Dollar

A good machine loading system should accomplish these objectives: (1) Indicate available machine capacities for handling any new work. (2) Point up bottlenecks and lags. (3) Assure proper sequence of job handling to meet schedules. (4) Control work flow, to process each unit in the shortest possible time, thus keeping work-in-process inventory at a minimum. (5) Control production by measuring performance against an established plan, resulting in better customer service and lower costs.

Remington Rand's Machine Loading System meets these basic needs the fastest possible way... *visibly.* At a glance, Sched-U-Graph visible charting tells you the load ahead of each machine, work station or machine center... the jobs that constitute that load... all scheduled starting and completion dates ... how much free machine time is available and when it is available. It's all explained fully in our new folder. Your free copy may easily lead to improving your plant's "Production per Dollar" ratio. Just circle KD738 on the coupon.

New Printing Calculator is Fully Automatic

For figuring costs, prorating overhead, and for many other figurework chores, plant after plant is turning to the new, fully automatic Model 99 *Printing* Calculator. This "2-in-1" figuring phenomenon features automatic division and multiplication, plus 10-key touch addition and subtraction, with all proof printed on Simpla-tape in black and standout red. Printed tape proof and 10-key touch method operation assure greater, more accurate output. Get all the facts on this newest step in figurework progress from folder C669, offered in the coupon.

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Yes, I'd like to have the literature circled.

KD738 LBV567 Rev. 1
X1383 Rev. 1 C669

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I-19

Profit-Building **IDEAS** For Business

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For more information, turn to Reader Service Card, Circle No. 471

600 lbs. OF BRONZE
melted in
23 minutes

This steel and non-ferrous centrifugal-casting foundry saves more than time through the use of Ajax-Northrup induction furnaces. Freedom from contamination and almost complete metal recovery are direct results of the high speed characteristic of the Ajax-Northrup melting principle. Electrical energy, used as the source of power, is expended almost entirely in the charge. Little is wasted on the refractory lining or outside the furnace, thereby making working conditions better and more efficient at the same time.

Many Ajax-Northrup furnaces are made to accept either ferrous or non-ferrous work . . . with impressive savings for both. With non-ferrous alloys, savings of over $33.00 a ton are reported in reduced metal losses alone. And for ferrous work, recovery is reported as high as 100% for nickel and 99% for chromium.

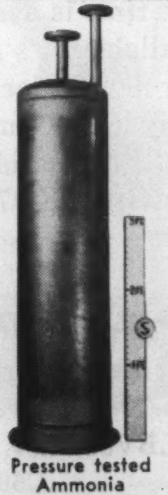
Economy recommends it, progress demands it; induction melting is fundamental to modern precision foundry work. Write for Bulletin 27-B . . . Ajax Electrothermic Corp., Trenton 5, New Jersey.

Associated Companies: Ajax Electric Company—Ajax Electric Furnace Co.—Ajax Engineering Corp.

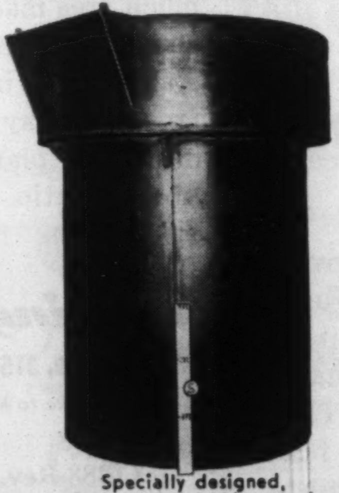
AJAX NORTHRUP SINCE 1916
INDUCTION HEATING-MELTING

SPECIAL ALLOYS plus EXPERIENCED TECHNICIANS
Assure WELDMENTS by STANWOOD that can "live with heat".

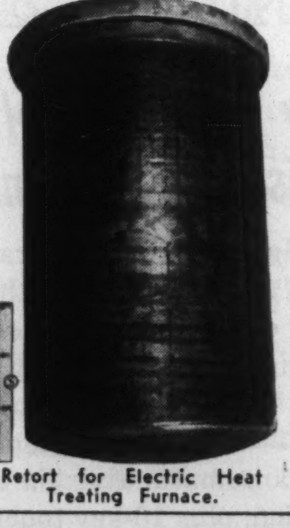
While we have made fabrications and weldments a few inches in diameter, the big, bulky, fussy, intricate jobs, which some shy away from, are our meat. These jobs are typical . . . correct metals used for the particular job involved . . . skillful, smooth fabricating . . . sound, gastight welds throughout. We do it every day . . . we'd like to do it for you. Send for literature.



Pressure tested Ammonia Dissociator.



Specially designed, pit type, quenching tank.



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chines are too light and cannot take the beating imposed on them. Perhaps because the material cost in American machine tools amounts to a relatively small percentage of total cost, our designers have not found it necessary to give concentrated attention to weight problems. I have noticed the composite construction of many foreign machines wherein the combination of plates, shapes, castings and weldments have resulted in lighter, stronger, machines which do a better job for the money than those of competitive American design." He also drew attention to the need for closer liaison between the machine builder and user. A problem that is now at hand which will take the utmost cooperation to solve is chip removal, which is becoming more and more difficult as machine capacity and speed increase.

Better Properties in Hand Forgings

Better design properties in commercial aluminum hand forgings are now available as a result of advances made in connection with Kaiser Aluminum's production of heavy aluminum forging ingots for the heavy press program. New mechanical property guarantees on 7075-T6 and 2014-T6 hand forgings offer substantially higher specification values and improved soundness standards which result in better transverse elongation values and fatigue properties. The application of the hand forgings to aircraft components will yield a part as strong as die forged equivalents. The hand forgings are used in prototypes and test models prior to the purchase of die forgings in larger quantities The hand forgings are made in Kaiser Aluminum's Erie plant, which is equipped to produce the new high specification standard and special purpose hand forgings in a wide variety of square, rectangular and round shapes with grain structure as specified. Maxi-

NEW

Arc Welding System

using

Murex® CROLOY Electrodes

for Welding CHROME-MOLY STEEL used in HIGH TEMPERATURE—HIGH PRESSURE SERVICE

See M & T's full line of electrodes at the AWS Welding Show Kansas City, June 8-10, Booth 250

- PRODUCES JOINTS AS DEPENDABLE AS THE METAL YOU WELD
- SIMPLIFIES THE WELDING OPERATION
- SAVES YOU TIME AND MONEY

IT'S NEW

IT'S PROVEN

IT'S ECONOMICAL

IT'S DEPENDABLE

M & T now brings you a new arc welding system using Murex CROLOY electrodes for fabricating and repairing chrome-moly steel equipment used in high temperature—high pressure service.

For years one of the nation's foremost producers of power piping and high pressure boilers has been using CROLOY electrodes in production. Their experience has proven the excellent operating characteristics of the electrodes, the dependability of the welds under high temperatures and pressures, the economy of the welding system.

With the new system you can greatly simplify preheat and postheat operations . . . you can practically eliminate underbead cracking, forget about costly defective welds . . . you can dispense with stress relieving on many weldments . . . you can weld chrome-moly steels more economically.

Murex CROLOY is a chrome-moly weld metal of outstanding stress rupture characteristics and high ductilities over a wide range of temperatures. Further information is available on this new welding system and the unique electrodes that have made it possible. Just write, or have a Murex man call.

METAL & THERMIT CORPORATION

Welding Division

100 EAST 42nd Street • NEW YORK 17, NEW YORK

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HAVE YOU HEARD ABOUT
GAR-FORMING

for ABSOLUTE ACCURACY in QUANTITY PRODUCTION?

This unique electroforming process was developed by Gar to give you quantity production of full-formed, or sheet parts — to reproduce dimensional accuracy and surface finish to the thickness of a single atom.

Using electrolytic build-up of the part on a master pattern, this process is uniquely suitable where internal accuracy and surface finish are critical. Gar-forming also permits "growing" of other components in place during part formation, to produce integral assemblies without fabrication distortion.

For production or prototype runs, the wide application possibilities of Gar-forming offer new, practical solutions to design and production problems. Send us your specifications . . . let us show you the specific advantages this unique process can offer you.

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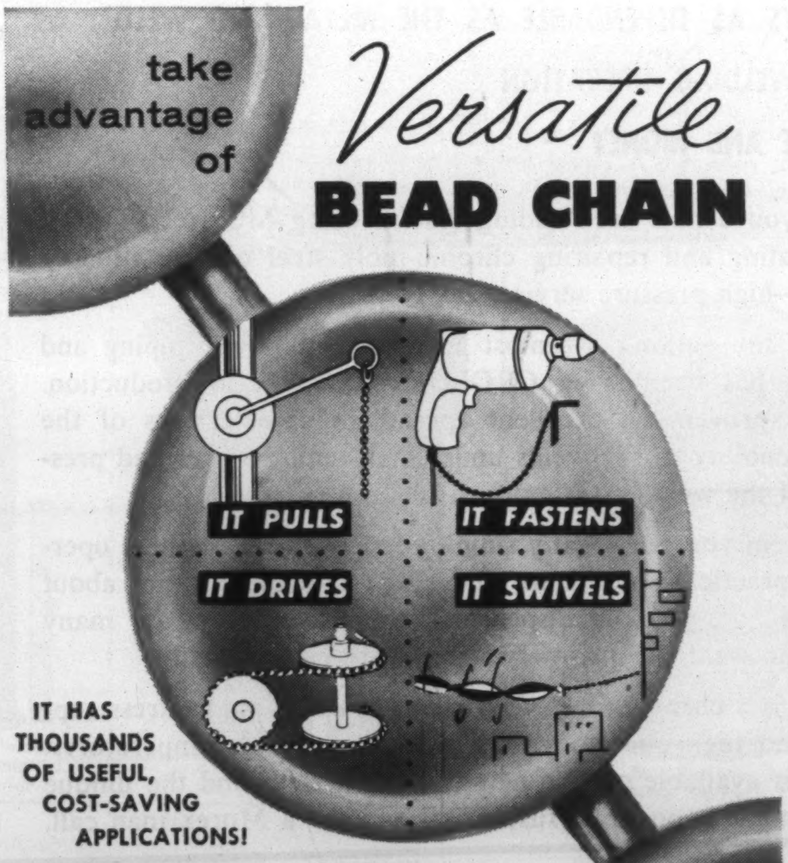


Versatile
BEAD CHAIN

IT HAS THOUSANDS OF USEFUL, COST-SAVING APPLICATIONS!

Bead Chain is available in 5 diameters from 3/32" to 3/8" with tensile strengths ranging from 18 to 200 lbs., in a variety of metals and finishes. No matter what the requirement, our engineers will be glad to assist you in solving your chain applications.

THE BEAD CHAIN MANUFACTURING CO.
15 Mountain Grove St., Bridgeport, Conn.

For more information, turn to Reader Service Card, Circle No. 512

News Digest

mum weight of hand forgings is 1000 lb.

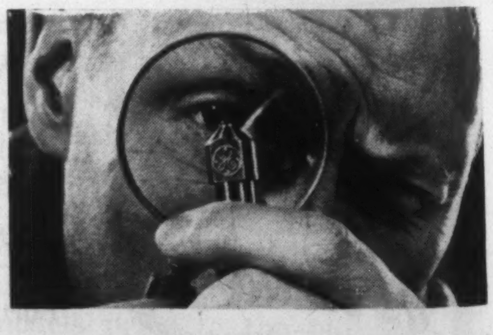
Better soundness

Improved properties of the two high strength aluminum alloys stem from new degassing and metal handling techniques. The result is consistent production of ingots free of gas porosity and substantially free of inclusions. Studies connected with production of 32-in. dia 7075 ingots for the US Air Force heavy press program led to the processing improvements. The methods have been extended to cover commercial production of ingots of all sizes. All ingots are reflectoscoped in the ingot bloom stage and the finished, hand-forged state.

Block number change

Specifications have been changed from the generally accepted AU-SR Block No. 5 standard to the improved soundness level of Block No. 3. Property guarantees include short transverse elongation of 6% for special product forgings in 2014-T6 aluminum, and 4% for standard forgings. 3% is the usual industry specification. In alloy 7075-T6 class 1 through 4, the same elongation property ranges from 4 to 6% in the special product forgings and 2% in standard forgings. The usual specification is 1%. The alloys have higher yield and tensile strengths.

(More News on page 256)



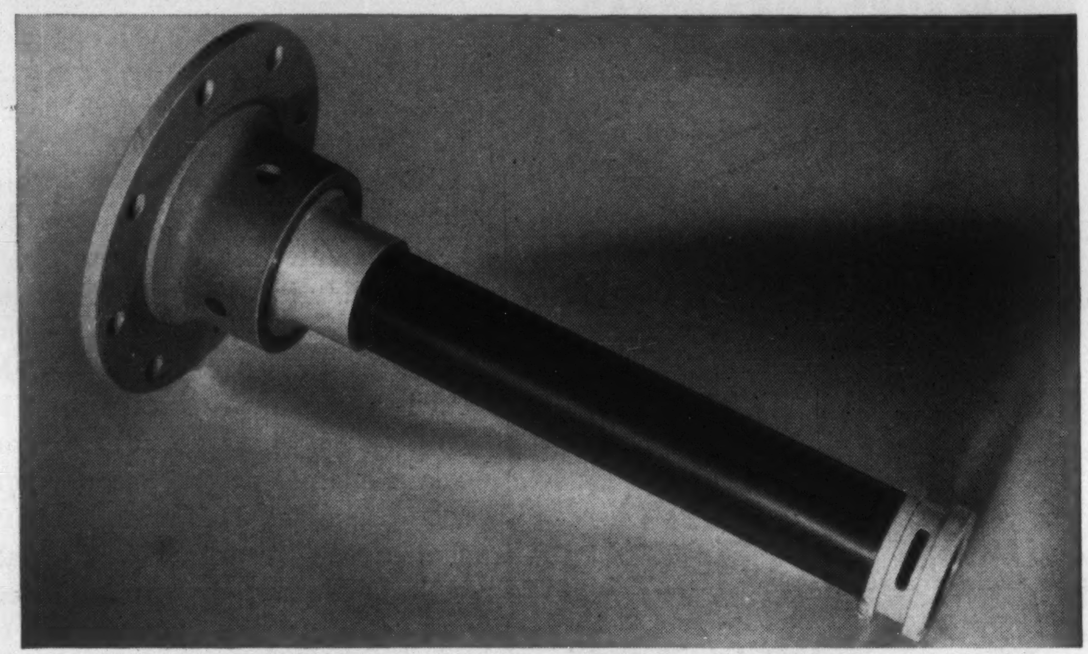
***New bonding system** for diamond tools developed by General Electric permits shallower mounting of diamond chips, exposing more cutting area. Mounting method uses titanium hydride and silver copper solder, and is expected to yield less costly diamond trimming tools and bits, since diamonds of smaller size can be mounted.*

TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD



High strength, light weight, excellent insulating and corrosion-resistant qualities make Taylor Epoxy Glass Base Laminate the ideal material for tubing in an aircraft fuel gage tank unit made by Avien, Inc.

When service conditions are tough—use Taylor special-purpose laminates

Designing for severe service? Then take a look at what Taylor special-purpose laminates can do. Taylor's resin chemists have developed special formulations of melamine, silicone and epoxy resins . . . for combination with a variety of base materials. The result is a line of laminates which offer the plus performance that your new designs may require.

Taylor epoxy laminates. Retain superior mechanical properties after exposure to high temperatures (above 430 F) . . . have outstanding electrical characteristics, moisture resistance and resistance to corrosive chemicals . . . setting these laminates apart as a means of solving difficult design problems.

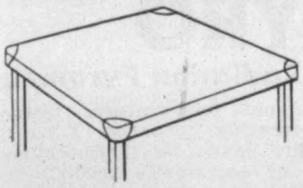
Taylor melamine laminates. Excellent resistance to arcing, electrical corona, flame and chemical attack characterizes these materials . . . useful in many electrical applications.

Taylor silicone laminates. These withstand temperatures up to 500 F . . . provide insulation where other laminates thus far cannot be used. They also possess high mechanical strength, low power factor and low moisture absorption.

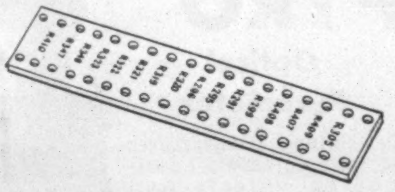
Sheets, tubes and rods of these materials are available in a range of sizes that will give you maximum economy of material in your manufacturing processes.

To help you in the application of these specialized materials to your specific product, Taylor offers the service of its experienced engineering staff. Call on Taylor for a consultation on your individual requirements.

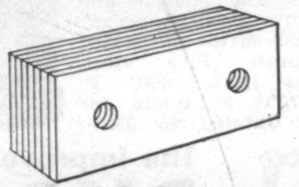
Tips for designers



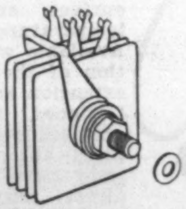
Furniture can make good use of the mar-resistant, tough surface afforded by Taylor Vulcanized Fibre plywood combination table tops.



Terminal strips for high-precision electronic instruments benefit by the excellent insulating properties of Taylor XXXP-301 hot-punch phenol laminate.



Heavy bumper blocks for steel mill use, made of Taylor Built-Up Fibre several inches thick, give long service under severe shock and abrasion.



Selenium rectifier plates are insulated by washers made of Taylor Grade 353 phenol laminate . . . chosen for its dimensional stability and mechanical strength.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.

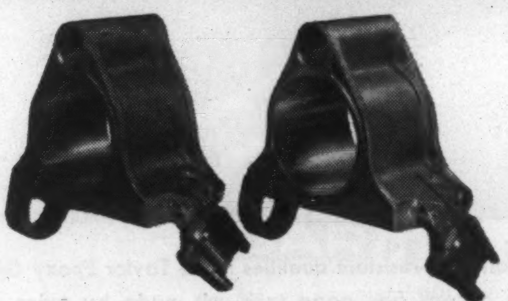
For more information, turn to Reader Service Card, Circle No. 381

Lorco

NOW...

YOU CAN TUMBLE PARTS YOU NEVER BEFORE CONSIDERED COULD BE TUMBLED . . .

WITH LORCO TUMBLING COMPOUNDS



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ALUMINUM YOKE, 5.5 lbs.
Tumbled loose in LORCO ZA Compound.

Amazing, but true! LORCO TUMBLING COMPOUNDS clean, degrease, deburr, color and finish parts you previously thought unsuitable for barrel finishing. LORCO Compounds increase metal finish, luster and color, while adhering to close tolerance of low, micro-inch finishes . . . and do it in reduced time cycles.

LET US PROVE IT TO YOU!

Without obligation, send us sample parts along with your blueprint specifications. We will accurately finish your parts and return them promptly with a detailed processing report. By arrangement, one of our engineers will personally help you with any finishing problems in your plant. Write for your copy of our fact-filled Catalog on all LORCO ZA Compounds. Inquire also about LORCO TUMBLING BARRELS AND TUMBLING MEDIA.

LORD
CHEMICAL CORPORATION

2068 S. Queen Street York 3, Pennsylvania

For more information, Circle No. 442

News Digest

See Competition for Porcelain Enamel

Porcelain enamel faces two serious problems in the appliance field, according to the annual outlook report of the Commercial Research Committee of the Porcelain Enamel Institute. First, the major appliances in which porcelain enamel is used are near their saturation point and new equipment bought is likely to be for replacement. More of the appliance dollar is going for television sets, air conditioners, and other products that are not owned by such a large proportion of the public and which do not use porcelain enamel parts. Second, porcelain enamel is facing serious challenges by other materials such as aluminum, stainless steel and new paints. A large share of the porcelain enamel market is occupied by the appliance field. Out of a total of $370 million porcelain enamel volume, $173 million is devoted to porcelain enamel parts in household appliances.

Architectural use

In the next largest volume market, building products, which represents a $102 million slice of the pie, this year's sales are expected to continue to climb with the volume of building.

Other markets

The outlook for other porcelain enamel markets—hospitals, refinery equipment, and food processing equipment—is seen as excellent. Porcelain enamel for cooking utensils faces severe competition from other materials and will have to sell hard to hold its position, according to the Institute.

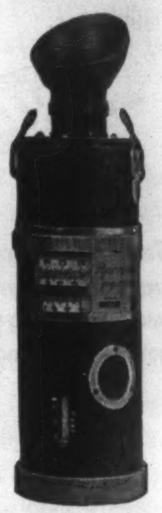
In general, the report concludes, the outlook appears optimistic but indicates that caution should be used. The seasonal high point for the year is here, and the Institute feels that real confirmation of an economic uptrend must wait until the second half of the year.

(More News on page 258)

PYRO
Instruments for Precision Temperature Measurements

PYRO
Radiation Pyrometer
Tells spot temperatures instantly in heat-treating furnaces, kilns forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature indicated on direct-reading dial at a press of the button. Any operator can use it. Two double-ranges from 1000° F. to 3400° F. Write for FREE Catalog No. 100.

PYRO
Optical Pyrometer
Determines temperatures of minute spots, fast-moving objects and smallest streams—at a glance! No correction charts or accessories needed. Easy to use—weighs only 3 lbs. Special types available to show true spout and pouring temps of molten ferrous metal measured in open. Five stock ranges from 1400° F. to 7700° F. Write for FREE Catalog No. 85.



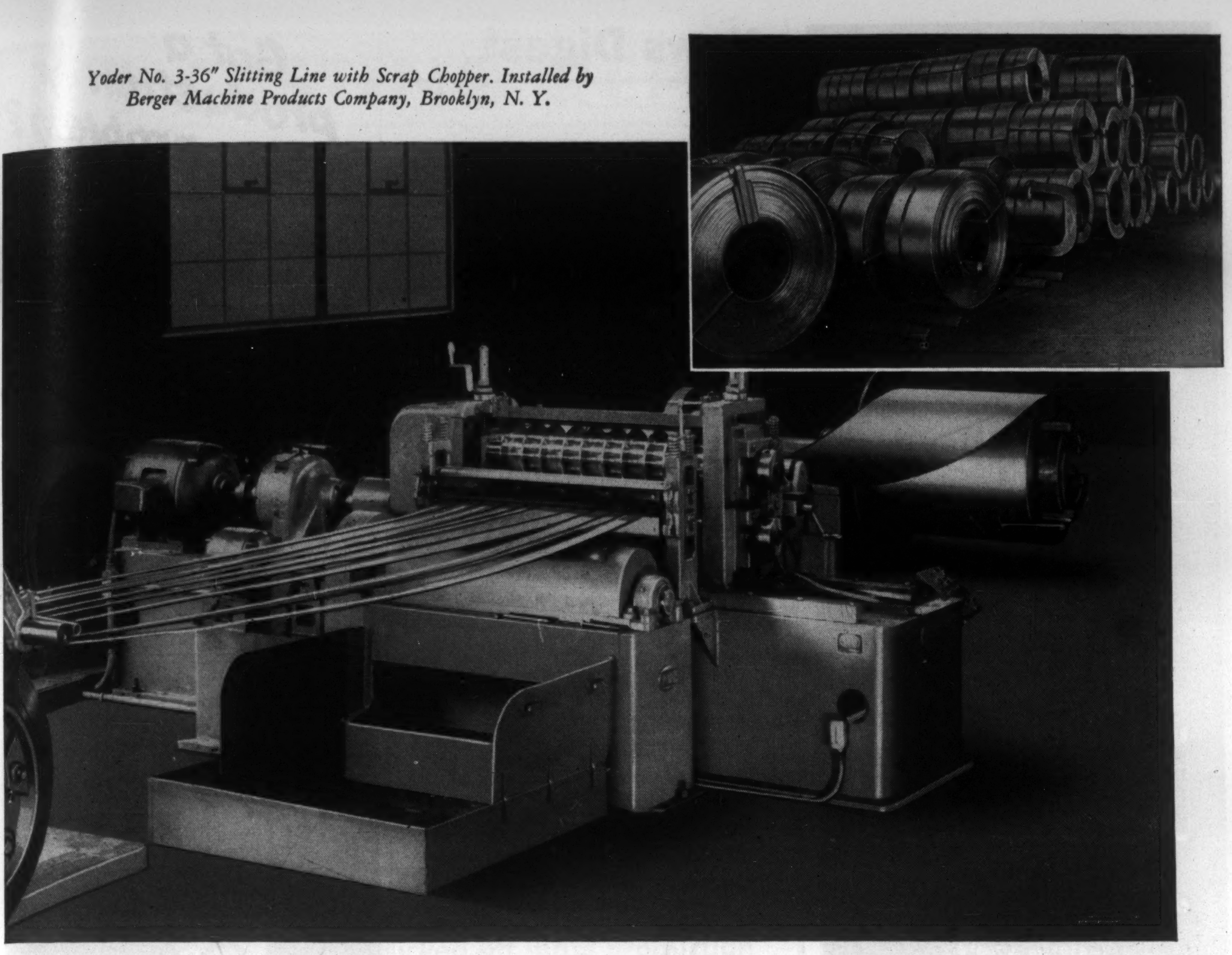
The Improved PYRO
Surface Pyrometer
The ideal instrument for all plant and laboratory surface and sub-surface temperature measurements. Available with large selection of thermocouples and extension arms for all jobs. Designed for ruggedness and accuracy . . . it features automatic cold end compensation, large 4¾" direct reading dial and shock, moisture and dust-proofed shielded steel housing. 5 stock ranges 0-300°F. to 0-1200°F. Ask for catalog No. 168.

PYRO
Immersion Pyrometer
The Pyro Immersion Pyrometer is shock proof, moisture proof, dust proof, immune to magnetic influences. Shielded steel housing. Instantly interchangeable thermocouples without adjustment or recalibration. Large 4" scale. Equipped with exclusive Lock Swivel. Ranges 0-1500 to 0-2500 F. Get FREE Catalogue No. 155.

The PYROMETER INSTRUMENT COMPANY
New Plant & Laboratory
BERGENFIELD 27, NEW JERSEY

For more information, Circle No. 523

Yoder No. 3-36" Slitting Line with Scrap Chopper. Installed by Berger Machine Products Company, Brooklyn, N. Y.



To Slit or not to Slit *your own strip...*

MULTIPLE ROTARY
Slitting Lines
YODER

In a certain strip mill, slitting big tonnages of heavy coils, a Yoder high speed slitting line for many years has been paying for itself about every three months. Such a line is, however, far too big and costly for tonnage requirements in most plants.

For metal fabricators and warehouses handling smaller coils and tonnages, Yoder offers a selection of lower cost slitters, uncoilers and recoilers, capable of handling an astonishingly wide range of coil weights, widths and gauges, at speeds sufficient to make their operation profitable on a surprisingly small volume.

The revised fourth edition of the YODER SLITTER BOOK, just off the press, contains production records, time studies and other data helpful in determining to what extent a slitter may be profitable in your plant, be your requirements small or big.

A copy is yours for the asking. Also estimates and recommendations, without cost or obligation on your part.

THE YODER COMPANY • 5546 Walworth Ave., Cleveland 2, Ohio

Complete Production Lines

- ★ **COLD-ROLL-FORMING** and auxiliary machinery
- ★ **GANG SLITTING LINES** for Coils and Sheets
- ★ **PIPE and TUBE MILLS**—cold forming and welding

ENGINEERING
YODER
MANUFACTURING

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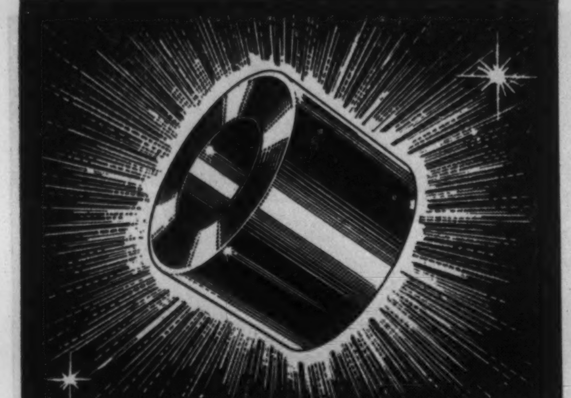

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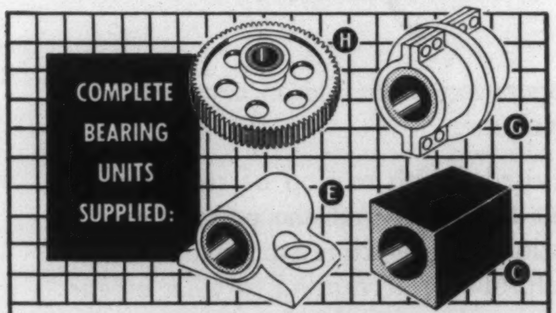
BUSHINGS

EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE (−450° to +700°F.)
OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR LIQUID GASES • NON-CONTAMINATING IN FOODSTUFFS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

GRAPHALLOY is widely used for self-lubricating piston rings, seal rings, thrust and friction washers, pump vanes.



BRUSHES • CONTACTS

GRAPHALLOY has high-performance electrical properties: *low electrical noise, low and constant contact drop, high current density, minimum wear!*

Brush Holders and Assemblies, Coin Silver Slip Rings and Assemblies available.

USE OUR 40 YEARS OF DESIGN EXPERIENCE!

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☐ Please send data on Graphalloy Oil-Free BUSHINGS.
☐ Send data on BRUSHES and CONTACTS.

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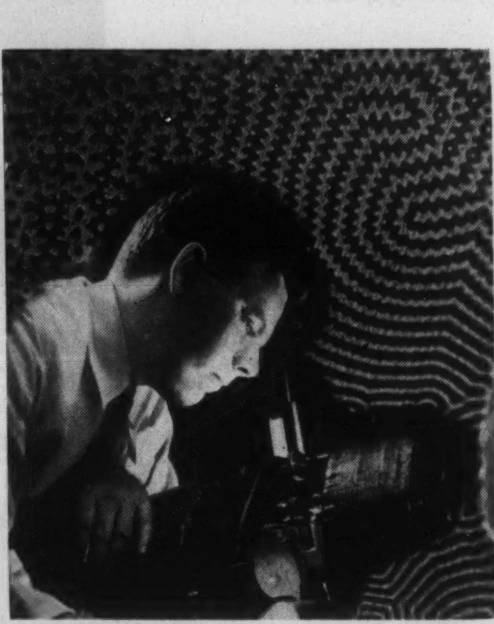
News Digest



Magnetic domains *shown in the background of this composite photograph of bismuth manganese are visible under polarized light microscope. Domains changes occur when magnetic field is changed, or when crystal is made subject to strain. Light and dark areas represent domains of alternate magnetic polarity, and their configuration is peculiar to this alloy. It is hoped that the ability to see the bands will add to the basic knowledge of the mechanism of magnetization in materials.*

Copper Standards for Oil Corrosion

ASTM Copper Strip Corrosion Standards are now available for use with Method D 130 in determining corrosive effects of automotive gasoline, aircraft engine fuels, farm tractor fuel, Stoddard cleaner solvents, diesel fuel, distillate fuel oil and certain other petroleum products. Available from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., the reference standards comprise thirteen various colored strips produced by six-color lithograph on aluminum, arranged according to increasing severity of attack. A marginal table lists number and description of reference strips according to Method D 130. Instructions for use are on reverse side.

In Method D 130 a polished copper strip is immersed at a definite temperature for a definite time in a sample of the material being tested. The strip is then washed, compared and evaluated

Got a production or design problem?
with
• GASKETS • PACKINGS
• WASHERS • SEALS • SHIMS
• BUSHINGS • "O" RINGS

85 YEARS OF
AUBURN "KNOW-HOW"
HAS THE ANSWERS!

Yes . . . over 85 years experience in engineering, designing, fabricating and production qualifies Auburn to help you find the ideal answer to your problem. Where gaskets, washers, and other sealing devices are concerned, Auburn engineers are tops in the field. Their know-how is yours—for the asking. We are tooled to fabricate in virtually any material:

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You'll receive
quotations, recommendations without obligation.*

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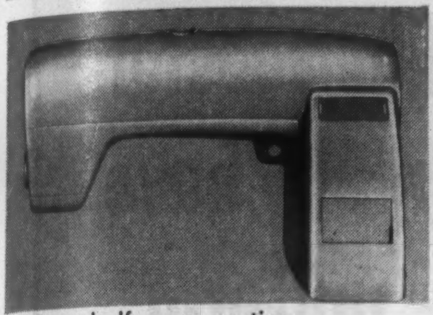
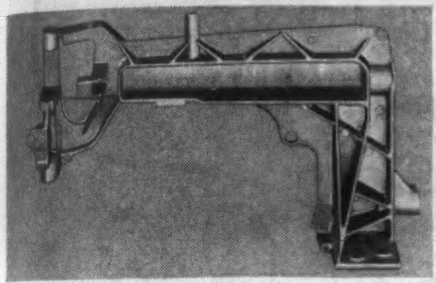
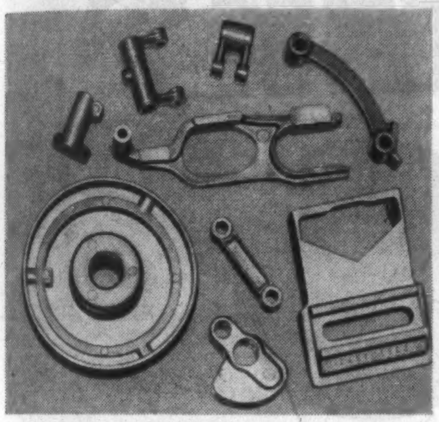
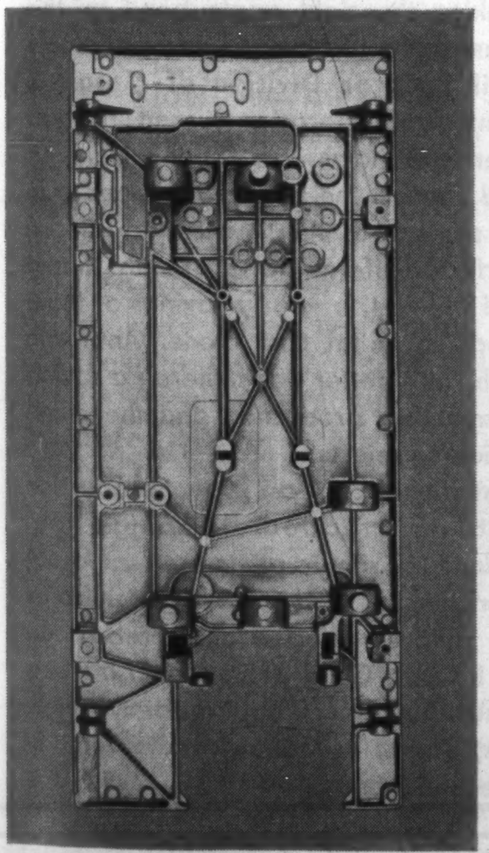
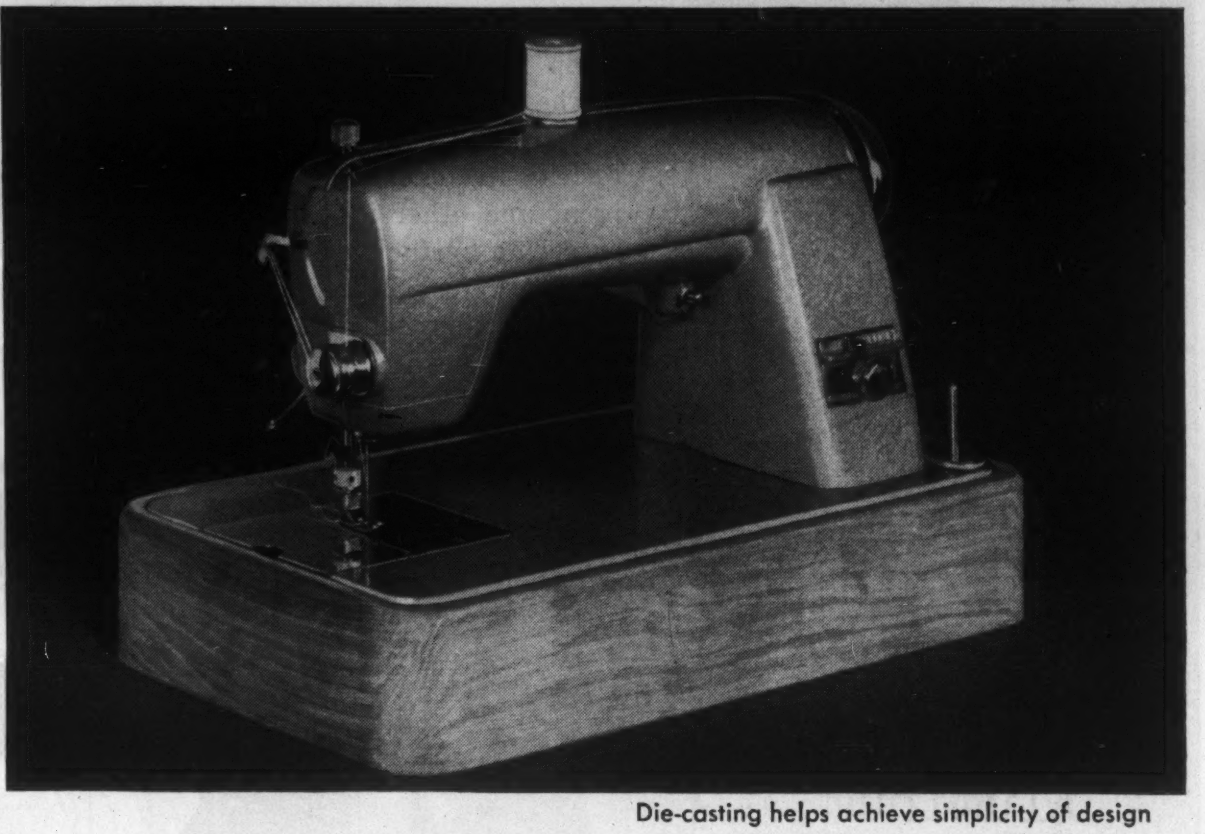
DIE CASTING REPORT


Front half, cover casting


Heavily ribbed main frame


Aluminum and zinc components


Intricate die-cast base


Die-casting helps achieve simplicity of design

New Materials and Methods plus Automotive Design Thinking . . .

Kicked off mass production of revolutionary portable sewing machine

Automotive design thinking contributed considerably to the development of a sewing machine now being produced by the New Process Gear Corp. of Syracuse, N. Y. Faced with a customer request to build a new portable, New Process engineers discarded 50 years of standard construction methods and decided to eliminate cast iron, minimize stampings, and make maximum use of aluminum and zinc die-castings. Thinking along automotive lines they designed 4 basic die-cast parts: a front and back cover (like an automobile body), a main frame and base (the chassis). Precision engineers worked closely with customer, suggesting additional ribbing and refinements to add strength and reduce weight.

PAY-OFF:

Sewing machine has clean functional lines, weighs 50% less than competitive models. Unit has 50 less parts. Gears are eliminated. Nylon cams and a positive chain drive achieve quieter, more positive operation. Machining and assembly time and costs are held to a minimum.

Creative engineering applied to aluminum, magnesium and zinc die-cast components can help you in planning a new product or part. The Precision team of design and metallurgical engineers can show you how to reduce weight, machine and shipping costs and simplify assembly. Write for the Precision story *"Die-Castings . . . Unlimited."* Address your request to: Precision Castings Co., Inc., 241 Walnut St., Fayetteville, N. Y.

PRECISION CASTINGS CO., INC.

World's largest independent producer: aluminum, magnesium and zinc die castings

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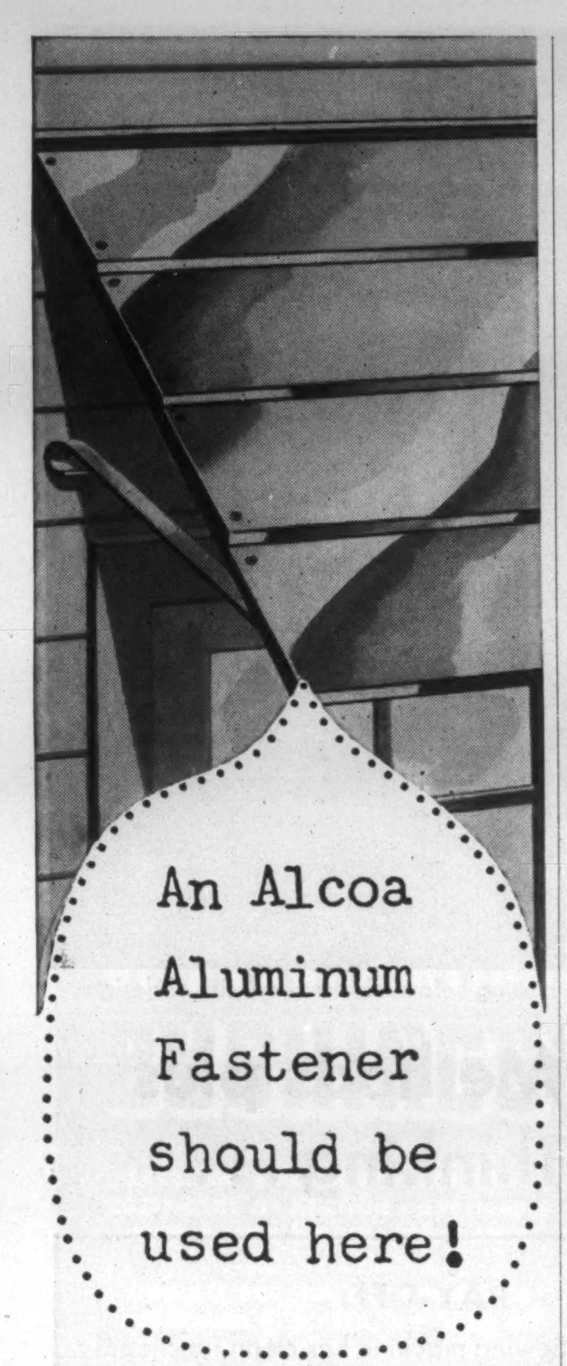
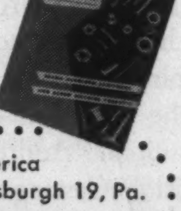


It's an aluminum awning assembly, worth the lasting strength of Alcoa® Aluminum Fasteners. You avoid galvanic and atmospheric corrosion. You get perfect color match; you get the very highest quality product. Your local Alcoa distributor has a complete stock.

P. S. In this awning assembly, we suggest an aluminum sheet metal screw from Alcoa's complete line of aluminum fasteners.



Aluminum Company of America
2251-E Alcoa Building, Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

name ____________________
title ____________________
company ____________________
address ____________________

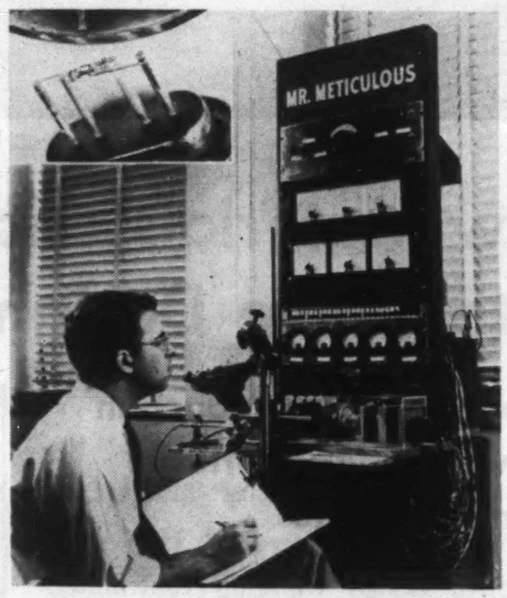
Always Fasten Aluminum with Alcoa Aluminum Fasteners

For more information, Circle No. 384

News Digest

with the Reference ASTM Copper Strip Corrosion Standards.

The visual standards are expected to be of value to laboratories in chemical, petroleum, paint and other industries where corrosion by fuels or solvents is a problem. They were prepared by the Central Scientific Co., in cooperation with a leading lithographer, and each set is inspected individually by an ASTM approval committee. Each set is priced at $25.

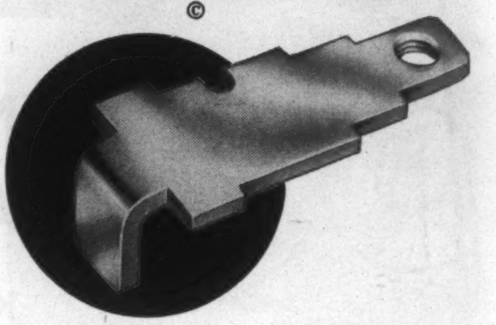


Locating the junction area *on semi-conducting transistors has been a job for a steady hand under a binocular microscope until the development of "Mr. Meticulous", a robot device that senses the critical junction area and solders a hair-thin wire to the proper spot. Insert shows finished tetrode transistor compared to the edge of a United States dime.*

Tool Orders Near 2-Year High

Industry is buying tools at a fast clip. A combination of favorable business outlook and the growing effect of automatic machinery and transfer equipment seem to be pulling together in the first half of 1955 to boost sales of industrial machinery and supplies. The new order index of the American Supply and Machinery

Spencer Thermostats must have uniform parts



Making the right angle bend on this brass contact terminal was troublesome until Spencer Division of Metals & Controls Corporation turned the job over to Mohawk. We not only stamped and formed the part, but tapped it in the same operation. Mohawk produced perfect, uniform parts at only about half the cost, a yearly savings of thousands in initial cost alone. And with Mohawk's better parts, there's a saving in smoother production and the elimination of rejects.

Mohawk can cut your production costs on threaded stampings, too. Intricate or simple parts are turned out economically and on schedule. Holes are squarely tapped and threads can be held to Class 3 fit. If you have a headache to buck on threaded stampings, pass it to Mohawk for savings in time and money.

Write or phone now.

mohawk
MANUFACTURING COMPANY
MIDDLETOWN, CONN.

For more information, Circle No. 342

Heavy tooth loads require gears of Nickel Alloyed Steel

For high compression strength and wear resistance

THE GEARS BELOW actuate movements of a giant, high-speed earthmover.

When the machine scrapes up a 23 cubic yard bite of earth to haul away at almost 30 miles per hour, the gears often carry extremely heavy loads.

But any reasonable set of demands can be met by use of nickel alloyed steels . . .

For Example

Where you need maximum wear resistance in the surface, plus all the surface compressive strength you can get, use a nickel alloy *carburizing* steel.

These steels provide extremely tough cores that resist shock loads, fatigue and bending stresses. In addition, they minimize the distortion in heat treatment which is a major cause of noisy gears.

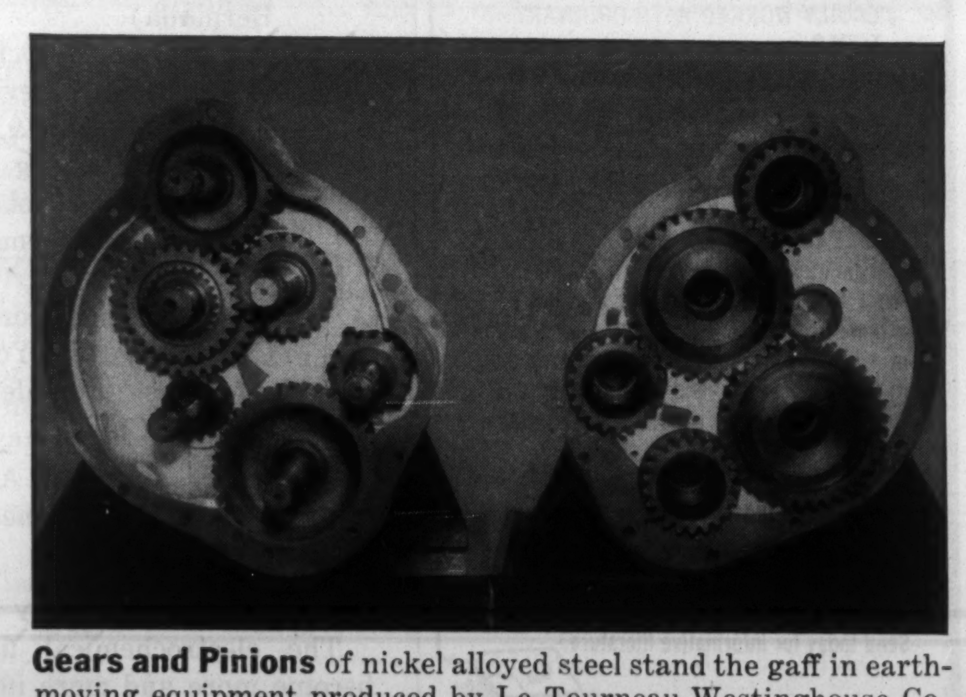
Where tooth loading is heavy, but surface compressive stresses and wear are not extreme, use a *direct hardened* nickel alloyed steel. It will give you the needed strength more consistently and in heavier sections than carbon grades.

Generally, steels containing nickel offer high resistance to shock, fatigue and multiaxial stresses. Moreover, you can readily machine nickel alloy steels before final heat treatment.

Booklet gives complete story

Meet the demand for gears that permit high speeds and heavy loads. For gears that run smooth . . . last long. Every engineer and designer should have a copy of "Modern Trends in Nickel Steel and Cast Iron Gear Materials." This illustrated booklet contains a wealth of information and data. It may be exactly what you want. It's yours for the asking. Write for your copy now.

INCO
TRADE MARK



Gears and Pinions of nickel alloyed steel stand the gaff in earthmoving equipment produced by Le Tourneau-Westinghouse Co., Peoria, Ill. The grades of steel used include 3310-H and 4820-H for severe duty, 4320-H for medium heavy service and 8620-H for relatively lighter tooth loads.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street
New York 5, N.Y.

For more information, turn to Readers Service Card, Circle No. 493

The Superior Structural Material . . .

Lamicor

offering an unprecedented combination of

CHEMICAL, ELECTRICAL, MECHANICAL and STRUCTURAL PROPERTIES

√ STRONGER THAN STEEL
√ LIGHTER THAN ALUMINUM
√ RESISTS CORROSION, ACIDS, PETROLEUM
√ CLEANS AS EASILY AS GLASS
√ MOISTURE-PROOF
√ WILL NOT CRACK, PEEL, WARP OR SWELL
√ DIMENSIONALLY STABLE
√ EFFICIENT THERMAL INSULATOR
√ LOW POWER FACTOR
√ HIGH ARC RESISTANCE
√ EASILY WORKED WITH ORDINARY TOOLS
√ AVAILABLE IN ANY COLOR

LAMICOR is a reinforced polyester laminate developed by Strick. In addition to its strength and durability, it can be worked with ordinary tools. **LAMICOR**, successfully used for 10 years in truck-trailer bodies, is now available in sheet form for a wide variety of fabricating uses.

Inert **LAMICOR** is finding wide application in chemical tanks, vats, ducts, hoods . . . in food processing and refrigeration . . . wherever corrosion, moisture or sanitation are problems.

Electrical grade **LAMICOR** with its excellent insulating qualities, is recommended for product design, in addition to its structural uses.

Send today for informative literature.

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STRICK PLASTICS CORP.
Philadelphia, Pa.
SALES OFFICE: 31-06 38th Ave.
Long Island City 1, N.Y.

For more information, Circle No. 439

News Digest

Manufacturer's Association hit a 22 month high in February when it reached 175.1. This is the highest since April 1953, when the new order index reached 182.1.

Good barometer

The index, based on the flow of orders received by association members who are manufacturers of production and maintenance equipment, tools and supplies, provides a fairly sensitive barometer reflecting both the level of production and the general attitude toward the future levels, as reflected by orders for production equipment.

The index is based on the volume of orders received during July 1948, which is rated at 100.

Spring Shows

Spring meetings of technical societies are bursting into full bloom this month. Significant materials developments are scheduled for presentation and discussion at:

Electrochemical Society's 107th meeting in Cincinnati
Society of the Plastics Industry (during a plush cruise on the Queen of Bermuda)
Metal Powder Association in Philadelphia (previewed in April issue of M&M)
Industrial Heating Equipment Assn. in Hot Springs
American Foundrymen's Society in Houston
American Society for Quality Control in New York
Nonferrous Founders' Society in Chicago.

The SAE and the American Welding Society will meet early in June.

Electrochemical Society

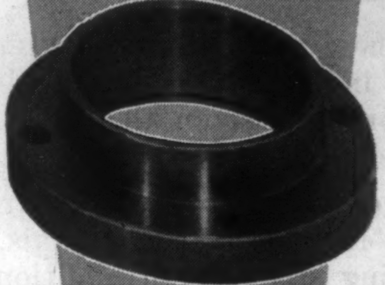
The electrochemical field has become more and more important for its contributions to materials developments. At its May 1 meeting it has scheduled full treatment of electrical insulating materials, semiconductors, luminescent materials, photoconductive

Promet *Engineered Bronze*

BEARINGS • BUSHINGS WEARING PARTS

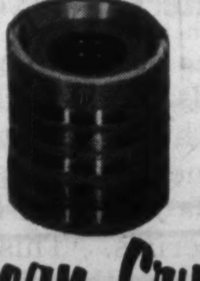
Stay on the job hours on end with never a doubt. They've got what it takes and can take it!

You needn't take our word for it. Take it from those who know: "We have formed a very high opinion of your products. They have served us well from a standpoint of wear and trouble-free usage. Your service and cooperation in expediting deliveries as required is very commendable."
—One of America's largest tool manufacturers.



"We find your Promet bronze of high quality and excellent in performance for use in our various pump assemblies. Your cast bronzes have excelled in their performance. Castings have also been of good sound quality."
—One of America's leading automotive parts manufacturers.

Write for free literature and service data sheets. Send blueprints, conditions of operation and other data for recommendations and quotations. You are invited to discuss your bearing problems with our metallurgists, engineers, and laboratory technicians.



THE American Crucible PRODUCTS CO.

. . . bearing specialists since 1919

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Stromberg-Carlson uses new Du Pont MYLAR* to increase switchboard wire production rate 46%

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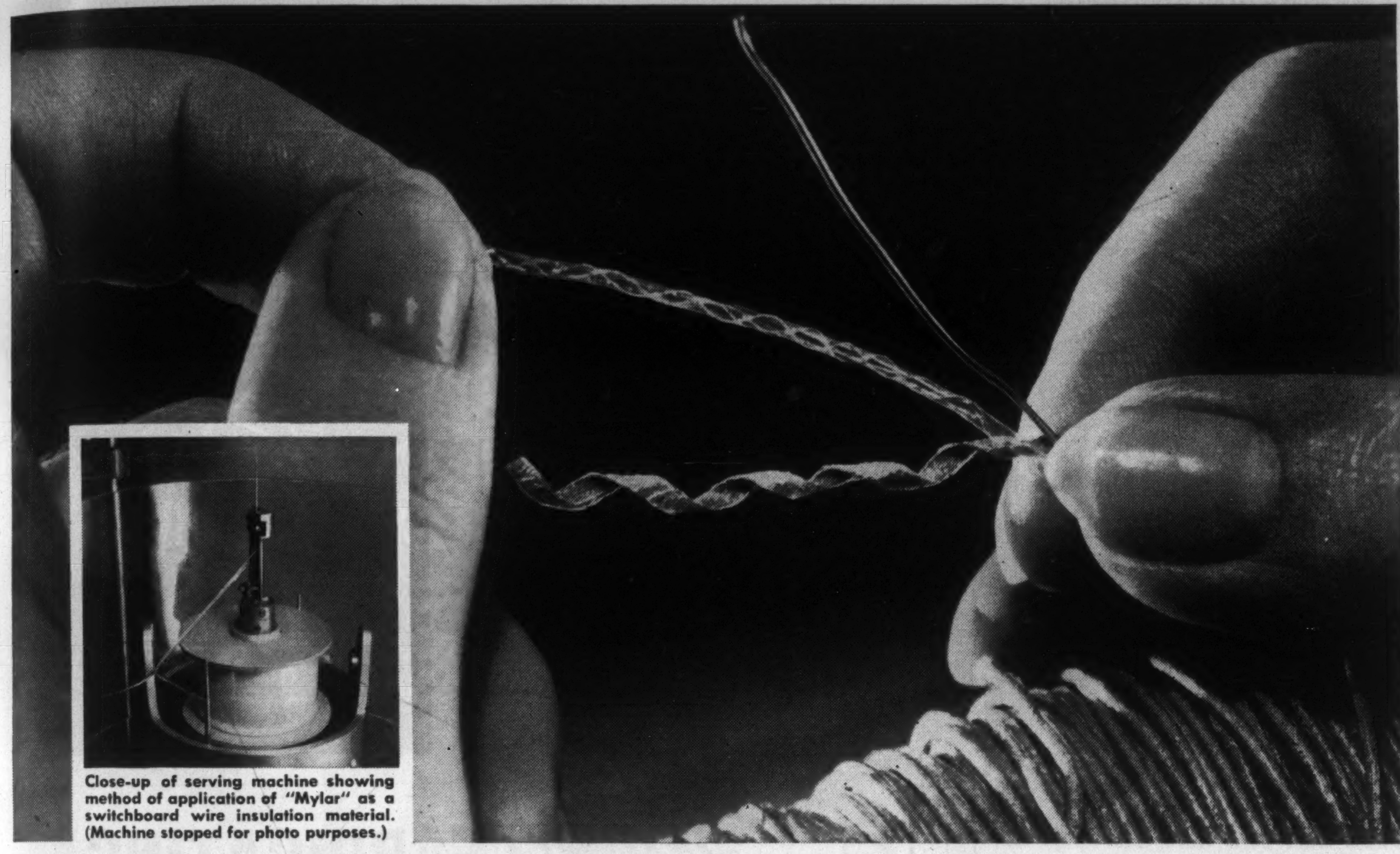


Close-up of serving machine showing method of application of "Mylar" as a switchboard wire insulation material. (Machine stopped for photo purposes.)

Unusual properties of "Mylar" make possible improved insulation

Here's another example of the outstanding improvements now possible with Du Pont "Mylar" polyester film—switchboard wire made by Stromberg-Carlson. The company reports that "Mylar," one-half the thickness but twice the tensile strength of the material formerly used, increases the production rate of the switchboard wire insulating machines up to 46%. And the superior insulating properties of "Mylar," along with its physical properties, give many other important advantages.

For example, Stromberg-Carlson tests show a three-to-one improvement, after humidity exposure, for the insulation made with Du Pont "Mylar." What's more, "Mylar" is tough, flexible, heat-stable, has good aging qualities . . . and it reduces the outside diameter of finished wire by approximately 5 mils.

HOW CAN YOU MAKE YOUR PRODUCT BETTER WITH "MYLAR"?

New Du Pont "Mylar," used alone or in combination with other materials, may well offer you an opportunity for improving your own products. "Mylar" has an average dielectric strength of 4,000 volts/mil. Tensile-strength average of 23,500 p.s.i. permits its manufacture in gauges as thin as ¼ of a mil (0.00025 inch). "Mylar" is inert to the attack of most solvents and insensitive to moisture. Its thermal stability permits an operating range of -60°C. to 150°C.

"Mylar" is a registered Du Pont trade-mark for its brand of polyester film.

Du Pont
MYLAR®
polyester film

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Find out more about new Du Pont "Mylar." Send for your free copy of the new booklet that gives you the facts and figures . . . shows you how this versatile film is already being used to advantage as slot and phase insulation in motors . . . layer insulation in transformers . . . as primary insulation and barrier tape for wire and cable.

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room 5 - T, Nemours Bldg.
Wilmington 98, Delaware

Please send me sample and further information on "Mylar" polyester film.

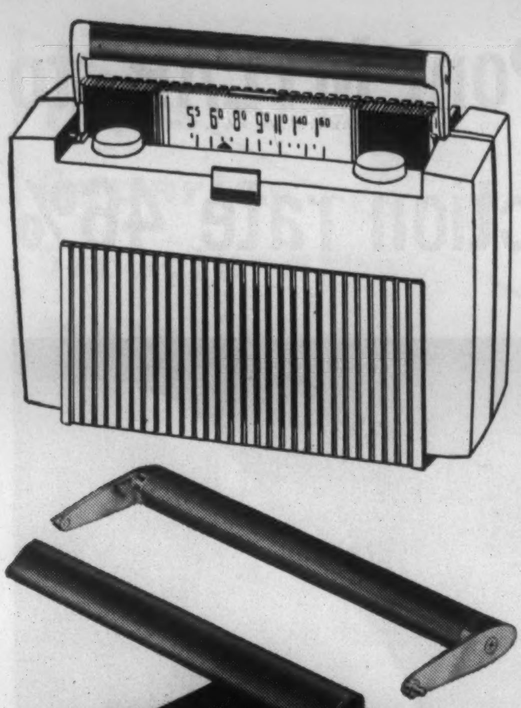
Name______________________________

Firm______________________________

Street Address________________________

City________________ State____________

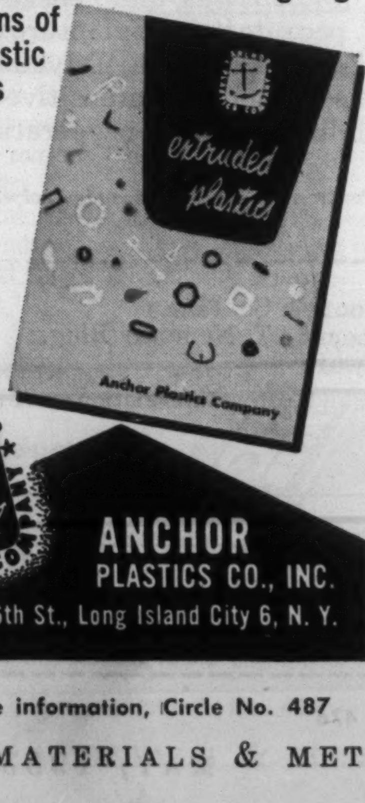
For more information, turn to Reader Service Card, Circle No. 476



WHY
ANCHOR PLASTIC
EXTRUSIONS
ARE USED FOR
RADIO HANDLES

Radio Designers were searching for sturdy, lightweight, colorful handles to be used on high-quality, 2-way portable radios. They chose Anchor extruded acrylic tubes with an egg-shaped cross-section because of their ability to meet exacting requirements for close tolerances and glossy finish. Colors selected were green, fawn, and ivory.

Perhaps an Anchor extrusion can solve a similar design problem for you. Why not write for our new brochure giving applications of thermoplastic extrusions and details on materials.



ANCHOR
PLASTICS CO., INC.
36-36 36th St., Long Island City 6, N. Y.

For more information, Circle No. 487

News Digest

materials, and, of course, its current reports on electrometallurgy.

Foundrymen's Society

The American Foundrymen's Society, meeting this year in Houston, May 23-27, has planned a program covering a broad scope. In addition to the technical papers on virtually all phases of casting, special shop courses will be held in brass and bronze casting, malleable casting, sand casting, and grey iron. Talks and round table discussions are scheduled for related foundry problems such as air pollution, dust control, safety, education, design needs and problems, industrial engineering, testing, and casting cost control.

American Welding Society

Meeting in Kansas City, June 7 to 10, the American Welding Society will hold its first national welding conference in addition to the technical sessions of the spring meeting. The subjects to be covered are: maintenance and repair welding; job shop welding problems; repair welding for farm implements; plastics welding; applications of welded polyethylene; applications for welded polyvinyl chlorides; how automatic controls can be applied to welding; automation for small run production; and automation for long run production. Over 100 companies are planning to participate in the welding show, at which welding equipment and accessories will be demonstrated.

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